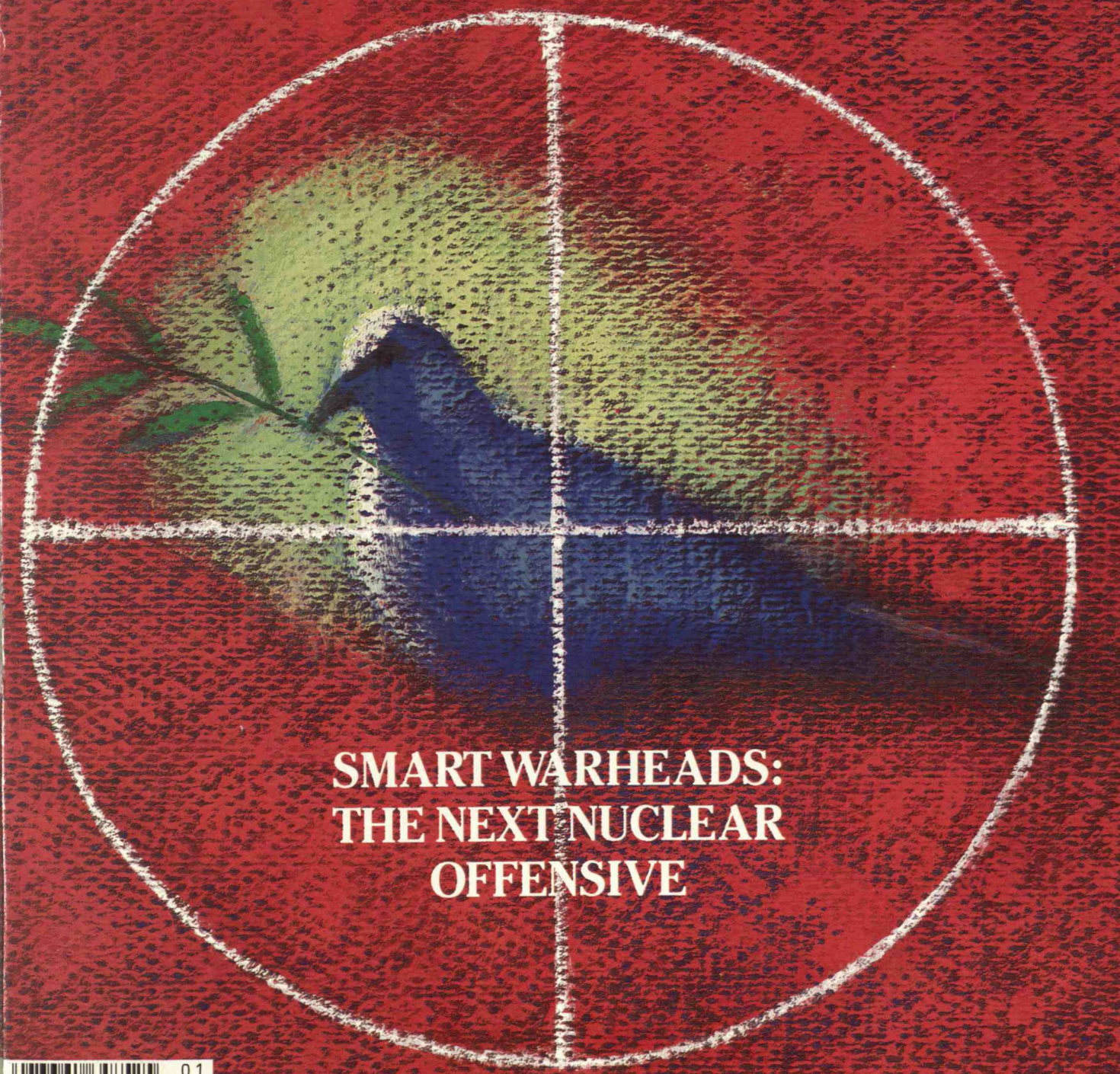
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Technology Review

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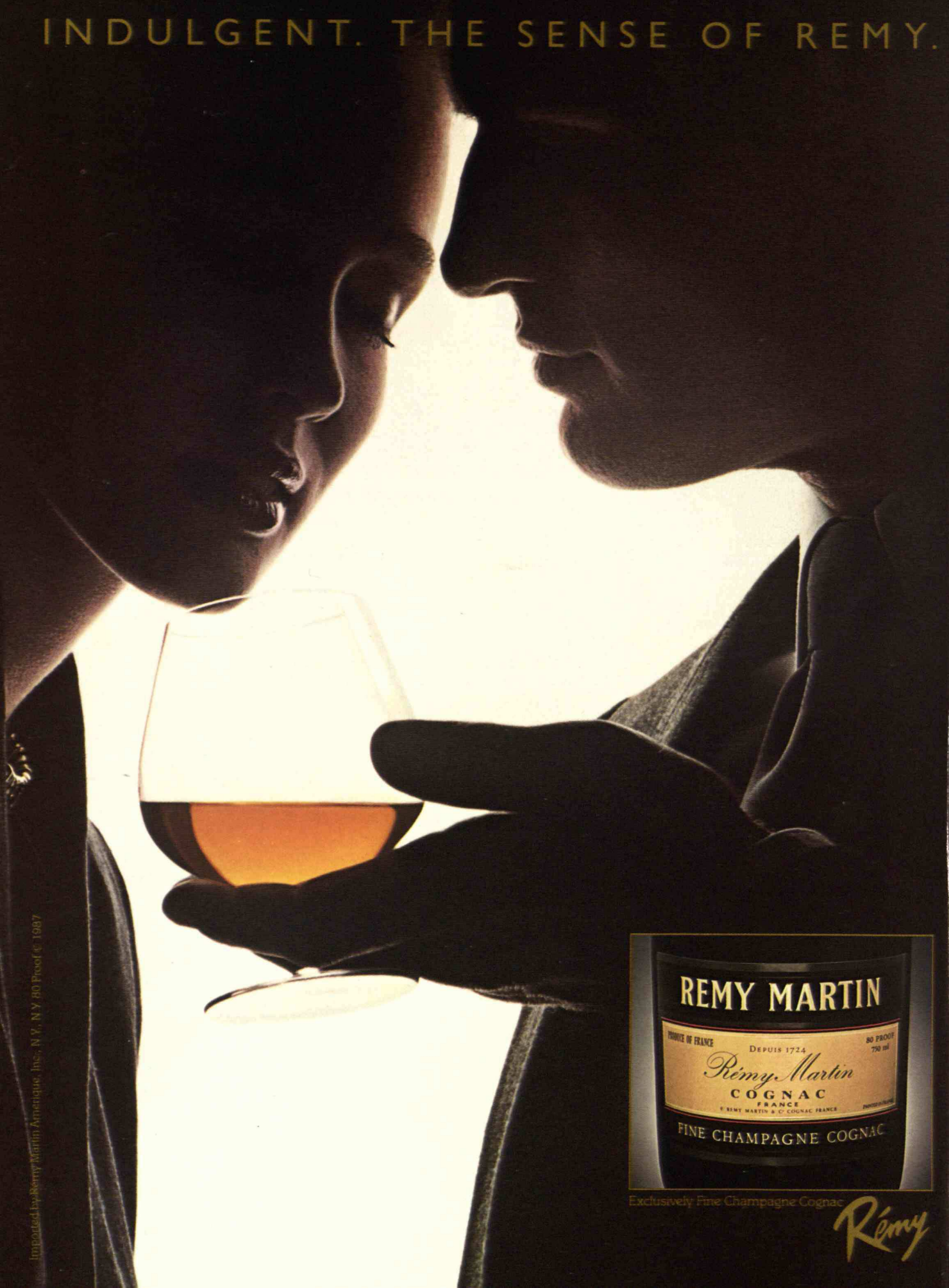
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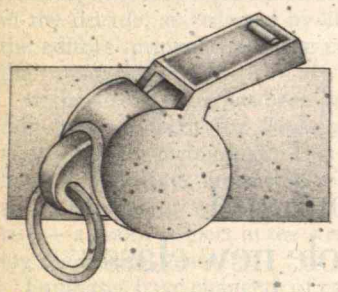
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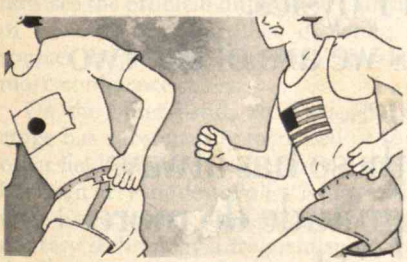
28 THE NEXT NUCLEAR OFFENSIVE



48 ENGINEERS WHO BLOW THE WHISTLE



58 BETTER DIAGNOSTIC IMAGES?



66 THE JAPANESE COMPUTER PROJECT

28 THE NEXT NUCLEAR OFFENSIVE
BY MATTHEW BUNN

We will soon be able to target ICBM warheads far more precisely. We need a flight-test ban to stop this development.

38 HIGH TECH GOES THIRD WORLD
BY HARLEY SHAIKEN

High-tech production abroad may keep American automakers competitive while eroding the U.S. economy.

48 MAKING THE WORLD SAFE FOR WHISTLE-BLOWERS
BY ROSEMARY CHALK

Stronger measures are needed to protect engineers and scientists who reveal dangers to the public.

58 NMR: THE BEST THING SINCE X-RAYS?
BY JUDITH E. RANDAL

A new technology produces startlingly clear images of the human body.

66 THE REAL CHALLENGE OF JAPAN'S FIFTH GENERATION PROJECT
BY ROBERT CHAPMAN WOOD

Even if this national computer effort fails to reach its technical goals, it will give Japanese industry a big advantage.

3 FIRST LINE

4 LETTERS

8 TRENDS
Materials technology and the Third World, healthier workers, superconducting ceramics, chemists' sixth sense, listen to the heartbeat, forest politics, Minitrends.

COLUMNS

20 SAMUEL C. FLORMAN
Anonymous heroes of technology.

22 MARSHALL I. GOLDMAN
Hong Kong business and Chinese labor may create Asia's next success story.

FORUM

26 Children who need technology—and parents.

BOOKS AND COMMENT

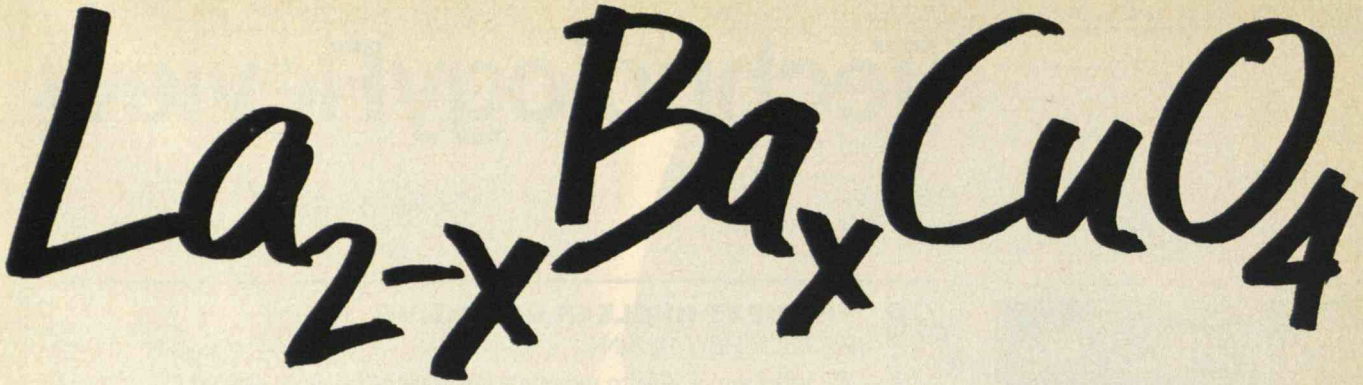
74 REINING IN THE NUCLEAR ARSENAL
Nuclear Fallacy
by Morton H. Halperin

76 THE WONDERS OF CHINESE TECHNOLOGY
The Genius of China
by Robert Temple

77 WHEN R&D GETS OUT OF HAND
RCA and the VideoDisc
by Margaret B.W. Graham

80 M.I.T. REPORTER

COVER
Illustration by Kevin Hawkes
Design by Nancy Cahners



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FIRST LINE

FROM THE EDITOR

Changed Not in Kind But in Degree



Fourteen years after energy self-sufficiency became a national goal, there are still new things to say about managing energy resources.

THIS new year of 1988 is the tenth anniversary of the Leadership Network, the cooperative that represents to advertisers *Technology Review* and eight other "thought leader" magazines. To mark the occasion, the network's director has proposed that each editor do a retrospective: how far has America come in the decade, as reflected by changes in the editors' priorities and the content of their magazines?

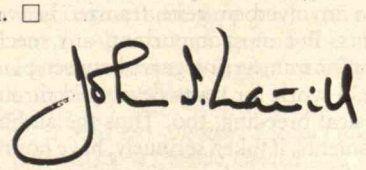
In the 1980s there has been but one totally new concern for *Technology Review*—genetic technology. This field has been fast-moving, promising remarkable social benefits as well as important new risks—a major subject in the *Review* during the last six years.

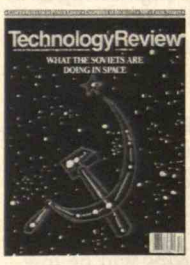
Emphases have changed, of course. Between 1976 and 1978 the *Review* published more than a score of articles on energy resources, conservation, and policy—fossil, wind, nuclear, solar . . . the works. The shortages earlier in the 1970s were vivid memories not well understood, and the problem of managing a society dependent on a depleting resource was a major new issue. In the parallel three-year span of the 1980s there has been only one article on energy resources and policy—"The Next Oil Crisis" by Michael Lynch (*November/December 1987*). As Lynch points out, there have been no technological "breakthroughs" to fundamentally change the way the world uses oil. But we now see the problem differently. Our view of how to manage other depleting resources is different, too—less agitation, more confidence.

On the other hand, the *Review*'s coverage has substantially increased of some other fields in which technological change has been very modest. Policy issues, rather than basic technical change, have made military technology a frequent subject for the *Review* in the last years of the 1980s. And workplace issues growing out of more autonomous machines and advanced communications were not so important in the 1970s as today.

Other topics that many consider current concerns turn out to have been in the *Review* all along. As early as 1976, there were articles on the environmental and political issues in the control of cancer; in 1977 and 1978, several reports on productivity, manufacturing technology, and innovation; in 1979 an important article on how Japan managed its technology; and in the same year an historic analysis of the cause of inflation by Robert M. Solow, 1987 Nobel laureate. Nuclear proliferation, ozone depletion, risk/benefit analyses, "whistle blowers," nuclear arms control, climate change, transportation, environmental integrity, economic modeling, waste management, international technology transfer, innovations to improve the quality of urban life . . . all were discussed in the *Review* between 1976 and 1978 and are still being discussed today.

Indeed, given everything that we have heard about the rapid pace of technological change, the surprising thing is that the policy agenda of a technological society has changed so little in the past decade. On the other hand, new insights bring these subjects into the pages of the *Review* again and again. One may be pessimistic about how slowly our society deals with the technology-based issues on its agenda; but one may also be optimistic about how often we have something new to say about them. □





The illustration on our October cover was credited incorrectly. The artist was Merle Nacht, to whom the editors and designers apologize.

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LETTERS



BIOTECH AND ENVIRONMENTALISM

In "Down on the Farm: Genetic Engineering Meets Ecology" (*January 1987, page 24*), David Pimentel occasionally forsakes logic completely, finding dangers in harmless experiments. In discussing use of the modified *Pseudomonas syringae* or "ice minus" bacteria to protect plants from frost, he asks us to consider what would happen if it caused disease in honeybees, which pollinate a substantial number of U.S. crops. Yet I know of no major honeybee disease that results from any close relative of the ice-minus bacterium.

In addition, Pimentel mentions the use of a *Bacillus thuringiensis (B.t.)* toxin produced in an engineered *Pseudomonas* to control caterpillars. He tells us it is critical to ensure that *B.t.* cannot also kill earthworms and beneficial soil insects, implying that there are no data on this subject. The fact is that the environmental effects and toxicity of *B.t.* toxin have been thoroughly studied over the last 20 years. Bacilli containing the toxin have been sprayed all over the United States to fight moth larvae with no harmful effects on any other organisms.

In what is perhaps the worst lapse in logic, Pimentel states that since engineered microorganisms can transfer genes to plants, some of the genetic characteristics added to crop plants could be transferred to weeds. First of all, no solid data of any kind suggest that a microorganism has been involved in gene transfer between plants. But most important, any mechanism for transferring genes between plants would work for traits developed through classical breeding, too. Thus the author's comments, if taken seriously, have nothing specific to do with genetic engineering and would imply that anything we do to improve crop plants by any approach is likely to be harmful. We know from experience that this is not the case.

The author suggests that growing herbicide-resistant plants could lead to greater herbicide use and more soil contamination. He also remarks that the threat of disease will be greater because the genetic diversity of crops will be low, and because plants become more susceptible to some diseases when they are treated with certain herbicides. But all this has little to do with genetic engineering. Furthermore, herbicides have been so helpful to farmers that without a single genetically engineered product herbicide sales have been a mainstay of the chemical industry for the last decade. Modern agriculture requires their use. What we can hope for are safer, more effective, and more selective herbicides. That is exactly what genetic engineering can offer.

Finally, Pimentel's notion that there is something Machiavellian about the chemical industry selling both herbicides and seeds as a package deal is absurd. If the use of resistant seeds with a corresponding safe herbicide is vastly more productive, agriculture will gladly pay the extra costs. Farmers already spend a fortune on chemicals, so why not use a system with additional weed control built in? Moreover, companies will certainly compete to offer the best system at the lowest price.

There will be problems with the new genetic-engineering technology, but I don't think Dr. Pimentel has addressed them successfully. We must use our imagination to think of realistic dangers, not fanciful ones. People must be educated in a wide variety of scientific disciplines so that intelligent controls can be legislated and executed by the proper government agencies.

RICHARD B. MEAGHER
Athens, Ga.

Richard Meagher is associate professor in the Department of Genetics at the University of Georgia at Athens.

The author responds:

Steven Lindow, the world's leading specialist on *Pseudomonas syringae,* reports that the bacteria may affect insects. It will be applied to crops such as strawberries to protect blossoms, and honeybees visit blossoms.

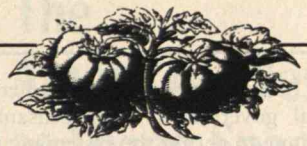
Meagher's comments on *B.t.* suggest that he is not familiar with the organism. Specific genotypes of *B.t.* affect insect groups in different ways, and some genotypes can be detrimental to earthworms. This is why Monsanto, which was involved in engineering *Pseudomonas* and *B.t.*, included earthworms as well as a variety of insects in laboratory experiments.

I did not state that solid data exist confirming the idea that microorganisms can

make lateral gene transfer between plants in nature. However, genetic engineers have reported that, based on laboratory trials involving transfers between plants, it could occur in the field.

If crops are developed that are resistant to herbicides, more herbicides will have to be used, and more environmental complications will result. Although some herbicides are safer than others, no herbicide is totally safe to non-target crops and the environment. Thus, the soundest policy is to carefully examine the benefits and risks of each program involving the release of herbicide-resistant crops.

Meagher agrees that the new genetic-engineering technology will produce some environmental and social problems, but he does not explain or rank these problems. Clearly, it will be costly and time-consuming to protect society and the environment from possible risks. But doing so is essential to maintain public confidence and the success of this important industry.



INTERNATIONAL TRAFFIC IN GERMPLASM

In "Seeds of Struggle: The Geopolitics of Genetic Resources" (*February/March, page 46*), Jack Kloppenburg, Jr., and Daniel Lee Kleinman highlight the apparent conflict between poor peasant farmers and rich multinational corporations. But the reality is more complex. For example, much of the germplasm that seed breeders collect is in the form of wild plants. This is hardly a form of exploiting peasant farmers.

Moreover, Kloppenburg and Kleinman fail to note an important distinction between plants that are discovered and those that are developed. Discovery may occur by accident at relatively low cost. But development—purposeful breeding—requires a profit incentive. Stop the profit flow and you halt the flow of constantly improved varieties.

I agree with the authors that a market solution is required for valuing germplasm resources. However, the proposal they endorse—the development of an international "plant gene fund"—is really counter to long-term practices. They argue against direct negotiations between suppliers and users of germplasm on the grounds that resources are distributed unequally among countries. But so are all resources. My concern is that an effort to negotiate a major international agreement will be hopelessly protracted.

WILLIAM LESSER
Ithaca, N.Y.

The authors respond:

We did not suggest that the central problem in the international germplasm controversy is the exploitation of poor peasant farmers by rich multinational corporations. While such exploitation may

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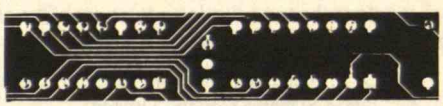
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well occur, the real issue is whether national governments—not peasants—will continue to permit the systematic free appropriation of what is unambiguously a useful natural and, we would argue, national resource. It makes no difference whether the germplasm collected is wild or the product of peasant labor. In either case, someone is getting something for nothing.

The unique nature of germplasm masks the asymmetrical character of the exchange. What distinguishes plant genetic resources from other natural resources such as coal or timber is that, with germplasm, the value of the whole is in the part. For this reason, a small and apparently insignificant amount of seed can be collected with no obvious loss to the supplying nation. Yet the loss is real: the nation does not receive a flow of benefit to balance the gift of genetic information.

Lesser's assertion that purposeful breeding requires a profit incentive is patently false. Economic arrangements are possible in which efforts to satisfy human needs shape the allocation of resources. For example, even in the United States the development of new plant varieties has historically been more a public than a private undertaking. Support for public applied breeding in this country is now being eroded because private breeders object to competition that is not profit-oriented.

Finally, we did not conclude that a market solution is required for valuing germplasm resources. We did emphasize the need for compensation, which is identical with a market solution only in the minds of some economists. We clearly noted the dangers of a market solution and expressed a preference for a form of compensation that does not rely on market mechanisms.



MICROCHIP HEGEMONY

Economic predictions based on technology require a little more rigor than Marshall I. Goldman displays in "The Shifting Balance of World Power" (*April 1987, page 20*). The Pentagon's assertions to the contrary, the Japanese microchip industry is in as nasty a spot as it's ever been. Three or four large planned Japanese plants have been put on hold indefinitely, and the rest are running at ruinously low percentages of capacity, actually driving up production cost. The wave is now breaking dramatically in the direction of small production shops—the kind with which the American chip industry is admirably equipped.

In more general terms, because Japan must import all of its oil, it has to get lots of dollars to pay for it by exporting goods to the American market. As for reciprocity, American farmers export more grain to Japan than to Russia and Europe combined, as well as a very large percentage of our beef production. A final irony lies in Goldman's point that Japan will soon be one of the world's foremost military powers: it is the U.S. government that is exerting the most pressure on Japan to increase its defense spending.

The Pentagon's microchip consortium should read Adam Smith: "I have never known much good done by those who affected to trade for the public good. It is an affectation, indeed, not very common among merchants, and very few words need be employed in dissuading them from it." As always, we will be protected by our overwhelming wealth—and our ingenuity if not rapacity in preserving it.

LINDSAY GILLIES
Conway, Mass.

The author responds:

I am concerned with more than just microchips. In particular, as the Japanese find themselves being pushed around, whether by the United States or Western Europe, they are going to insist that they be treated with more respect. To accomplish that, of course, they will need more political clout, which also means more military clout. Even if the microchip industry should cease to grow in Japan, the Japanese would probably continue to direct resources into military activities. I would agree wholeheartedly that the Pentagon is being very shortsighted in its insistence on an increase in Japanese defense spending.

I have trouble with the idea that our "overwhelming wealth" will protect our nation. As we move away from an economy based on raw materials, such wealth may not be as important as it once was. Moreover, if we should continue to find it difficult to produce tangible goods, how long will people want to hold onto dollars? Our trade balance with the rest of the world is rapidly approaching that of the Soviet Union, which is nothing to be proud of.

FLYING WHALES?

The caption that accompanies the photograph of me in "Of Whales and Weather" by Stephen Strauss (*July 1987, page 11*) indicates that the gear I'm working with is to be attached to whales. This is not the case. The gear is a small radio-controlled helicopter used for making unique observations of whales.

BRUCE R. MATE
Newport, Oreg.

FAIL-SAFE BIRTH CONTROL

In "The Crisis in Contraception" (*May/June 1987, page 46*), Elizabeth B. Connell gives a negative connotation to irreversible sterilization. But the majority of American couples are happy to have the option of a vasectomy or tubal ligation. As the years advance, playing Russian roulette with any other form of contraception causes much anxiety.

JEAN R. NITZ
Kalamazoo, Mich.

CHEMICAL TRUTHS

In the article I wrote with Michael J. Bennett, "Chemicals: An Industry Sheds Its Smokestack Image" (*July 1987, page 36*), late editorial abridgements left errors.

First, Rohm and Haas has always been primarily a specialty chemical firm. The recent acquisitions reported in the article were in electronic chemicals. Second, although Amoco and Exxon have had only limited success in some small, high-service lines, they have been quite successful in larger-volume specialty chemicals. For example, Amoco has a strong position in specialty plastics and Exxon in lubricant additives.

CHARLES H. KLINE
Fairfield, N.J.

MUSICAL DEMOCRACY

In "The New Music Biz" by Suzanne Gordon (*January 1987, page 10*), Michael Comins and John Glazel contend that synthesizers are destroying music. I disagree. Just as home computers have opened up the arcane world of number crunching, low-cost synthesizers have democratized music recording. The shoe salespeople, garage mechanics, receptionists, and mail carriers who now have access to synthesizers and multi-track recording machines are going to be the musical geniuses of tomorrow.

RICHARD KADREY
San Francisco, Calif.

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In 1942, John Vincent Atanasoff completed the world's first electronic computer. This special-purpose digital machine not only proved the feasibility of electronic computation, but also led directly to the ENIAC, the first general-purpose electronic computer, and through its successors to the computers of today. Yet Atanasoff's contribution was first ignored and then engulfed in controversy since it was uncovered some twenty years ago. Through extensive analysis of patent trial records, the authors demonstrate the validity of a U.S. Federal Court ruling that upheld the priority of Atanasoff's invention and its causal linkage to later computers. In the process, they unfold an intriguing drama of corporate maneuvering, individual strife, and human foibles.

Barbara Drygulski Wright, Editor

Women, Work, and Technology
Transformations

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The contributors to this important and diverse collection examine the ideological, sociological, and economic contexts within which technological change influences the lives of women. They discuss future prospects for women, especially in the field of computer science, and examine the growing phenomenon of university-affiliated technology parks and their impact on both professional and non-professional women, as well as for society at large.
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High-tech materials mean declining Western demand for Third World mineral resources such as Bolivia's tin.

Materials Technology and the Third World

Fifteen years ago, the eminent scientists and thinkers known as the Club of Rome shook the world with a vision of ever-larger populations chasing rapidly diminishing resources. The club commissioned a study, *Limits to Growth,* that anticipated a five- to tenfold increase in demand for major global resources by the year 2000. The study suggested that basic materials would be depleted before developing countries could muster the technologies to shape their own future.

The report was criticized for failing to consider technological progress; that criticism now appears well founded. As the United States, Japan, and Europe develop new materials and adopt conservation-minded production methods, declining demand for mineral resources—not depletion—is threatening Third World economies.

The declining use of traditional raw materials is already obvious in transportation and communications. For example, alloys, plastics, and resin-based composites are steadily replacing metal in automobiles. The average automobile will be 26 percent lighter in 1990 than it was in 1980. The use of copper has declined from 30 pounds to 10 pounds per automobile since 1950.

In communications, 500-pound satellites do the work of transoceanic telephone cables weighing 150,000 tons, and optical glass fibers are replacing copper in telephone lines. The first transatlantic optical telephone cable, which should begin operations in 1988, will carry almost 40,000 conversations at once—four times the capacity of the last coaxial cable, laid in the mid-1970s. U.S. copper savings in communications averaged 200,000 tons a year between 1980 and 1984.

Computers have accelerated the switch from traditional raw materials. For example, computer-aided design and manufacturing have helped reduce the size and thickness of containers. Beverage-can manufacturers now produce 7,000 more containers per ton of metal than was possible a decade ago.

Recycling adds to the savings—and reduces demand. In 1985, reycling provided the West with 48 percent of its lead, 38 percent of its copper, 25 percent of its aluminum, 24 percent of its zinc, and 21 percent of its tin. According to G.A. Jewett and Associates, a Toronto-based consultant on technological change, scrap recovery is likely to meet future Western demand for copper.

Technology Forecasting

For countries that rely on mining and traditional metals for export income, advanced materials technologies do not bode well. With little domestic or Third World demand for their natural resources, these nations face a worsening balance of payments and declining funds for housing, water, health services, and education.

"These new, lighter, and better materials could have a devastating effect on the economies of developing countries that are too dependent on individual commodities," says Sergio C. Trindade, executive director of the United Nations Centre for Science and Technology for Development (UNCSTD). He notes the dependence of many nations on only one or two export commodities. For example, copper makes up 85 percent of Zambia's exports and 40 percent of Chile's. Copper and cobalt comprise half of Zaire's exports.

Shortages—and hence high export prices—are no longer anticipated for any traditional minerals for several decades, according to an UNCSTD bulletin on materials technology and development. Recent studies cited in the bulletin suggest that by the turn of the century the world will consume only two to three times the volume of raw materials it used in 1975. That is still high, but far below the *Limits to Growth* estimates and low enough to delay the depletion of resources significantly. G.A. Jewett and Associates recently predicted steady declines until the year 2000 in Western demand for steel, copper, tin, lead, and zinc, and a 2 percent annual growth rate for aluminum.

Alexander Kouznetsov, economic affairs officer for the United National Conference on Trade and Development, believes that the

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"dematerialization" of Western manufacturing is permanent. Says Trindade, "The challenge [for Third World exporters] will be to read the trends in new materials development and substitution, and reorganize their economies accordingly."

Kouznetsov, an engineer, economist, and former associate professor at the Foreign Trade Academy in the Soviet Union, is one of more than two dozen specialists that UNCSTD asked to prepare a global overview of existing materials technology. The group has shared its findings with about 40 developing countries, and these governments have begun to establish national and regional bodies to find ways to adapt to the economic impact of new technologies.

Six nations—Mauritius, Nigeria, Egypt, Swaziland, Cameroon, and Tanzania—have joined forces under the Economic Commission for Africa to design a system that would give an early warning of the effects of technological advances on demand for raw materials. Brazil, Argentina, Colombia, Venezuela, and Mexico have done the same in Latin America.

Anthony Goka, head of planning and analysis for Ghana's Council for Scientific and Industrial Research, says these technology-forecasting units are essential. According to Goka, "Governments must be aware of new developments in the field so that they can upgrade their processes or diversify. The danger in these developments is that you will wake up one morning and find that your products have been replaced and your industry has ground to a halt." □

IAN STEELE is an Australian journalist specializing in Third World development.



PHOTO: GERMAIN HARNDEN, WNYCOSH

Healthier Workers

The availability of health clinics that specialize in diagnosing and treating work-induced diseases has increased dramatically in recent years. By 1986, 65 occupational health clinics had opened, compared with 15 in 1982. In addition to improving health directly, the clinics are expanding doctors' knowledge of occupational illness. However, some clinics have met with challenges from employers who fear being held responsible for illnesses that clinics might attribute to the workplace.

Occupational health clinics diagnose patients with job-related diseases and often give expert medical opinions in workers' compensation cases. They also treat patients, although usually a clinic recommends treatment that a person's regular doctor can manage. The illnesses clinics encounter include many cancers, chronic kidney diseases, neurologic disorders, and reproductive impairments as well as chronic respiratory diseases such as emphysema, asthma, bronchitis, asbestosis, and byssinosis.

Clinics also conduct screenings for common occupational diseases such as asbestosis, and clinic staffs often include health educators who hold programs for workers on detecting or preventing these diseases. Some clinics employ industrial hygienists who can recommend engineering controls to reduce workplace hazards.

Recently, New York's legislature funded the first state network of occupational health clinics. An appropriation of $1 million for the first year will support two clinics and the planning of four more. According to Joel Shufro, director of the New York Committee on Occupational Safety and Health, advocates in the legislature came from both parties, including "the [Democratic] governor's office [and] the Republican chair of the Senate Labor Committee."

Independent financing—from universities, unions, governments, and patient fees—distinguishes occupational health clinics from corporate-funded services that provide pre-employment exams and urgent care for workplace accidents. Financial independence helps ensure that medical information will be private between patient and clinic. Some occupational health clinics are affiliated with a university, including those at New York's Mount Sinai Medical Center and San Francisco General Hospital. Others, such as Buffalo, New York's Union Health Care Coop, are freestanding, often with close labor-union associations.

Occupational clinics are beginning to close information gaps about the illnesses that are caused by workplace exposures. Stephen Mooser, administrator of the Yale Occupational Medicine Program, says there is "a profound lack of information on the human toxicity of industrial substances." But he goes on to point out that "the increase in the number of clinics has spawned informal sharing of patient information about previously unre-

Occupational health clinics are providing information about illnesses that are caused by workplace exposure to chemicals.

ported occupational diseases." This has given physicians important data about the effects of workplace chemicals on humans.

The Association of Occupational and Environmental Clinics (AOEC), founded in September 1986, is intended to encourage cooperation. According to AOEC president Dr. Laura Welch, director of the Occupational Medicine Program at George Washington University Medical Center, the organization wants to establish formal links among clinics to create a national data base on workplace exposures, occupational illnesses, and treatments. AEOC could also supply government officials with information, aiding "agencies that now regulate hazards based primarily on animal data," says Welch.

Paying for Health

Companies do not always welcome the clinics, because the occupational health specialists who work in them are more likely than most doctors to associate a health problem with the workplace. That connection is often vital to workers' compensation claims. Contributions to state workers' compensation systems, and hence insurance rates, are tied to successful claims. According to Dr. William Morton, who runs an occupational health clinic at the Oregon Health Services University in Portland, insurance companies generally don't challenge accident cases, but they are "trying to hold the line on toxic illnesses."

In North Carolina workers have been threatened with losing their jobs for using occupational health clinics. According to Susan Pollitt, a North Carolina Occupational Safety and Health Project attorney, "Workers at a controversial hazardous-waste incinerator were told they would be fired if they went to an occupational health specialist at Duke University." Morton says he has seen many similar cases. He notes, however, that such incidents don't occur in larger, more established companies.

Last year, a Dayton-Walther Corp. foundry in Dayton, Ohio, became the first company to file a lawsuit against an occupational health clinic. It is suing the Greater Cincinnati Occupational Health Foundation and its two doctors for $2 million, charging them with medical negligence and fraud. Over 100 Dayton-Walther employees had filed workers' compensations claims for silicosis, injuries caused by vibrating tools, and other occupational illnesses. Although one court has dismissed the suit, the company is appealing. Nicholas Ashford, a lawyer and occupational health policy expert at M.I.T., has told the *New York Times* that the claim "smacks of intimidation." He believes the company's case is so weak that its aim could be "to stop doctors from practicing occupational medicine."

Morton has also been threatened with a lawsuit. LaValley Industrial Plastics wrote his dean at the Oregon Health Services University after the physician told two workers that their respiratory diseases were related to occupational chemicals. The company wanted the clinic to apologize and retract the implication that LaValley condones unhealthy working conditions. But the doctor responded that he might sue LaValley for harassment, and no suits have been filed. □

TOBI LIPPIN is a staff member of the North Carolina Occupational Safety and Health Project.

Superconducting Pottery

The recent discovery of ceramic materials that superconduct—that is, carry electricity without resistance and hence super-efficiently—is on any list of major scientific achievements of the 1980s, perhaps even of the century. These materials begin to superconduct when cooled to around −320°F, a relatively "warm" temperature easily attainable using inexpensive liquid nitrogen. In contrast, conventional metallic superconductors have to be cooled to −450° using expensive liquid helium.

Unfortunately, the promise of practical applications for superconducting ceramics may not be easy to realize. Their early commercialization depends on success in three areas of research: the basic science of superconductivity, the development of applications, and ceramics processing. Kay Rhyne, program manager of ceramics and superconductivity in the Defense Advanced Research Projects Agency, says ceramics processing is the most critical of the three.

Unlike metals, ceramics are inherently brittle. Also, until about five years ago, the processing technology for ceramic devices was developed empirically and not supported by a firm base of scientific knowledge. "The U.S. advanced-ceramics industry is an emerging industry in which products and processes are still being defined," says M.I.T. materials science professor H. Kent Bowen. It has been difficult to manufacture reliable ceramic components consistently. No wonder, then, that Jenifer Taylor, assistant professor of ceramic engineering at Alfred University, reports a flood of inquiries "from frustrated people who want to use the new ceramic superconductors but can't get information on how to process them." Researchers remain hopeful that the developing science of advanced-ceramics processing is applicable to ceramic superconductors.

Materials that superconduct when cooled by liquid nitrogen could have many applications, but scientists must find better ways to make them.

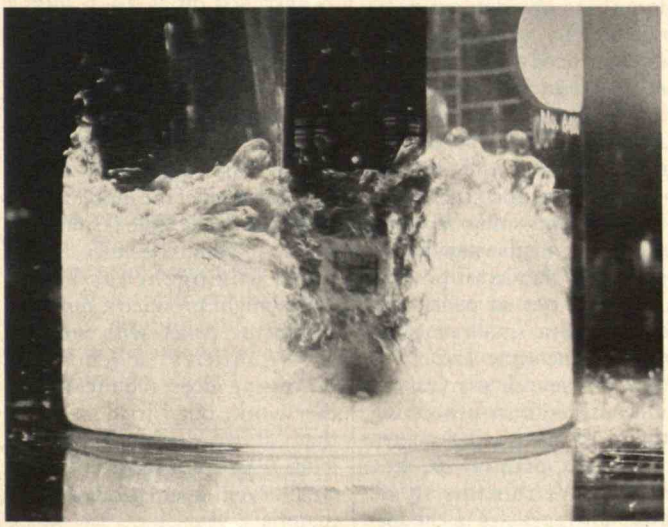
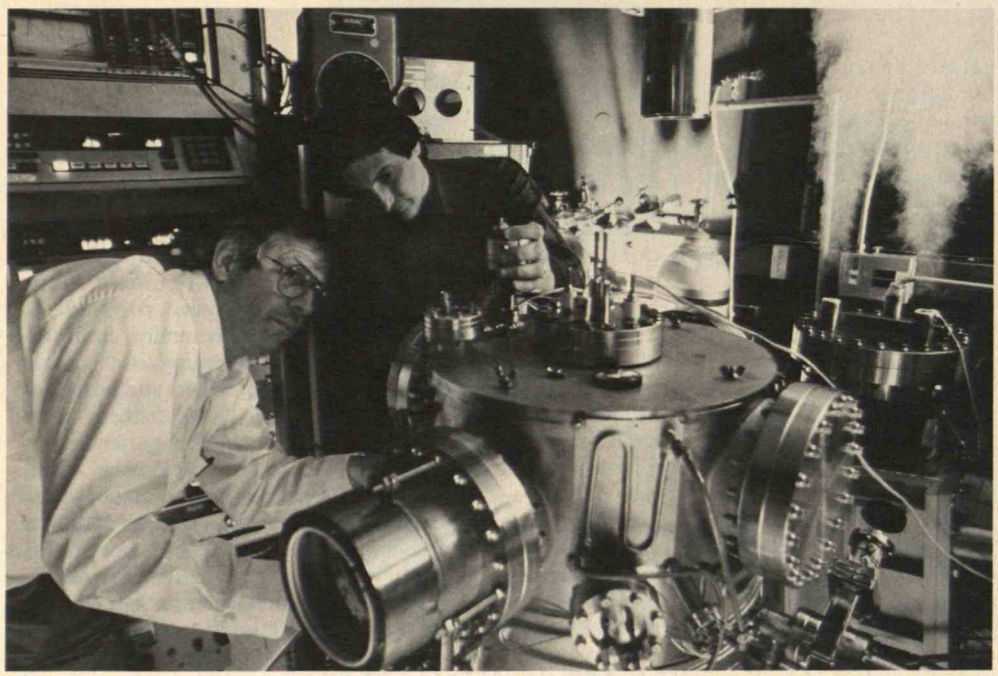


PHOTO: SEPP SEITZ

IBM researchers are among those developing new superconductors. Here they are producing thin film wafers by evaporating metals.



Many high-technology ceramics are made from mixtures of powdered ingredients that are fused by "sintering," or firing in a high-temperature furnace. At present, most superconducting ceramics are produced by grinding together oxide powders of barium, copper, and the rare-earth element yttrium; heating the mixture at a high temperature to initiate a reaction; pressing the material into a pellet; and firing the pellet at an even higher temperature to sinter the individual particles together. By applying only a few advanced techniques, researchers at the M.I.T. Ceramics Processing Research Laboratory have substantially increased the density, homogeneity, and strength of the superconducting material. In general, in the new material larger chunks of powder are sorted out so pellets are formed from small particles of about the same size.

This research proves the value of ceramics-processing studies in improving superconductor properties, but much more remains to be done. The particles in the improved pellets are still relatively large by a ceramist's standards, and making them finer is a top priority. However, according to David Lewis, head of the Ceramics Branch of the Naval Research Laboratory, the best techniques now available for synthesizing powders do not work well for superconducting materials.

Chemical processing would be a better approach, says Donald Ulrich, senior program manager for the Directorate of Chemical and Atmospheric Sciences at the Air Force Office of Scientific Research. This means that instead of grinding components together, researchers would dissolve the components in a solution and let the individual molecules react. The resulting powder would be finer and more homogeneous and hence might produce a superconductor pellet with superior qualities. Chemical processing does require further work, but Ulrich warns that "if we don't get away from traditional approaches, we'll never have reproducible materials."

Bowen emphasizes the value of applied research. "We must recognize how much we learn by doing," he says. "In this case, we cannot wait to understand all the issues before we attempt to commercialize products." However, everyone agrees that more basic research is needed as well. No existing theory explains the phenomenon of high-temperature superconductivity in ceramic materials.

And there is also the possibility of finding additional high-temperature superconductors. "The chances that Paul Chu [the discoverer of the material with the highest critical temperature so far] hit the best material possible on the first try are slim," says John Gustafson, head of the Electronic Materials Department at GTE Laboratories. "So it's exciting that there could be other materials out there with better properties. If we can get superconductivity to room temperature, it could revolutionize life." □

ELIZABETH A. THOMSON is a technical writer at M.I.T.

Chemists' Sixth Sense

Scientists are combining high-tech materials such as semiconductors, fiber optics, and piezoelectric crystals with plant and animal tissues to make devices capable of detecting a wide variety of chemicals. Sensors that can measure extremely low concentrations of important and even hazardous substances will soon be ubiquitous. They could be applied in such diverse areas as health care, environmental monitoring, and the control of industrial processes.

Chemist George G. Guilbault and his co-workers at the University of New Orleans are making sensors to detect pesticides. The group is using piezoelectric crystals similar to those that keep accurate time in quartz watches. When electricity is applied to the crystals, they vibrate at a characteristic frequency.

The New Orleans researchers coat each crystal with a protein that is sensitive to a particular chemical. When the protein comes into contact with that chemical, the crystal's frequency changes. This change can be measured with sensitive instruments.

Guilbault's sensor can detect as little as a few molecules per billion of a pesticide such as malathion or parathion. Thus, it could reveal pesticide residues on foods to ensure that consumers and food handlers are not exposed to dangerous amounts. Sensors could tell farmworkers when it is safe to return to a field sprayed with pesticides, or give an immediate warning of a leak in a chemical plant that manufactures pesticides.

In addition, the New Orleans group is developing sensors to discourage fruit and meat smuggling. Guilbault says U.S. Department of Agriculture researchers have found that acetoin, a gas given off by bacterial decay, indicates whether any of a number of fruits are present but is less reliable at revealing when meat is nearby. An acetoin detector Guilbault has developed is sensitive enough to measure "vapors from fruit and meat in sealed containers," he notes. He is also working on sensors to detect vapors given off by cocaine, morphine, or heroin "in a sealed suitcase."

Yet another sensor that Guilbault has created is an alternative to the standard breathalyzer test. The device is less expensive and smaller than instruments now in use, Guilbault states, making it especially useful for portable units.

George Guilbault, center, is developing pesticide detectors by applying proteins to crystals like those that keep time in quartz watches.



Fibers and Chips

Instead of monitoring electrical changes in crystals, chemistry professor W. Rudolf Seitz at the University of New Hampshire is devising sensors that change color. The fiber optics that he uses in them allow him to measure harmful chemicals from a safe distance and in difficult-to-reach areas such as lake bottoms and underground waste sites.

Seitz attaches an indicator that changes color in the presence of certain chemicals to one end of a light-carrying glass fiber. At the other end, a spectrophotometer accurately measures the color shifts. A similar detection device could rely on changes in the intensity of fluorescence or reflected light. For example, substances that fluoresce such as benzene and toluene can be very sensitive indicators of gasoline leaking from underground storage tanks.

Seitz is working on "an indicator that would respond to TNT in groundwater." This is a concern at military installations that store large amounts of explosives. The indicator would react with TNT, turning a distinctive brown color. But many environmental factors can affect this sensor, so it is still at the initial test stage, Seitz reports.

A team including professor Matthew Wayner of the University of Texas is investigating chemical sensors to measure very low concentrations of nerve toxins, such as rattlesnake venom and nerve gas. The research is based on the idea that toxins produce their effects when they combine with receptor sites in cells, Wayner explains.

To make a sensor sensitive to nerve toxins, Wayner and co-workers extract a nerve-cell enzyme from a cow's brain. His team purifies the nerve-cell enzyme and attaches it to a semiconductor chip. That way, the semiconductor's electrical properties change when a nerve toxin couples with the enzyme.

"This technique will have wide applicability," Wayner thinks. As with Guilbault's sensors, the use depends on the protein chosen. For example, since protein in cancer cells has unique receptors, enzyme-semiconductor sensors might monitor therapies for the disease. "You might develop an implantable detector," Wayner suggests. The device would reveal the progress of a treatment by constantly sending out indications of the amount of cancer cells present. □

MICHAEL ROOT is a free-lance writer specializing in chemistry, biology, and the history of science and technology.

Listen to the Heartbeat

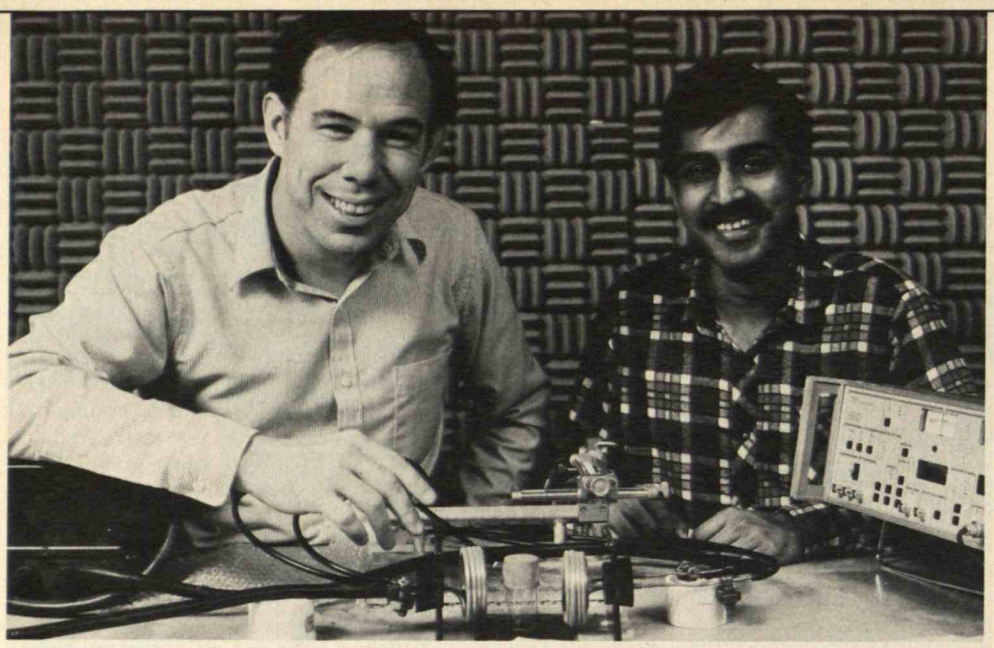
Arizona medical researchers are turning silence into sound, hoping to detect cancers early. And in Michigan, silent graphs of a person's chemical composition, heartbeat, and blood pressure are being converted into music, in effect giving medical technicians an extra sense.

Scientists at Arizona State University, led by Bruce Towe, associate professor of biomedical engineering, are tuning in to tumors inside mice. Towe traces his research to the ideas of B.E.W. Nordenström, a Swedish pioneer in the study of bioelectric currents, and to efforts in the 1970s by physicians Muriel Schauble and Mutaz Habal. Schauble and Habal, working at the State University of New York Upstate Medical Center and the Syracuse Veterans Administration Hospital, found that tumor tissue attracts electrons more strongly than does nonmalignant tissue. They also showed that tumors in hamsters become more electrically negative as they become more malignant.

The Arizona researchers first inserted microelectrodes into cancerous masses. But this procedure is invasive. In addition, the electrodes stimulated "injury currents"—flows of charged particles from broken cells. "There's no way to separate injury currents from tumor currents," Towe says.

A novel application of a physical phenomenon called "Lorentz forces" has solved this problem. Lorentz forces make an electrical conductor vibrate when it is in a magnetic field. Towe's group puts

PHOTO: COURTESY: GEORGE G. GUILBAULT



Bruce Towe, left, and graduate student Mohammed Rezaul Islam detect tumors in a mouse by placing it between the coils of powerful electromagnets.

mice into a magnetic field to make their current-conducting tumors vibrate, and the vibrations produce sounds the scientists hear through a receiver that filters out other body noises.

As yet, however, the Arizona researchers don't know the exact nature of a tumor's sound while it is within the rodent. The responses to Lorentz forces appear to vary greatly from mouse to mouse. But Towe believes that if sounds can be reliably connected with tumors, doctors might be able to detect cancer even before a tumor forms.

Towe is trying to verify Nordenström's theory that ions migrate through the blood to a new tumor, causing an electrical imbalance. "There's some belief that the electrochemical imbalance occurs first, before the actual tumor appears," Towe notes. He speculates that reversing the current might halt tumor growth.

A Familiar Tune

At Michigan State University, music is wafting out of the biochemistry laboratory of Charles Sweeley and John F. Holland. "One day we were discussing the idea that modern medical instrumentation really constrains the analytical chemist to only a single sense—that is, sight," Sweeley says. "You see a table or you see a graph."

To add another sense, the team began to use a computer and a Moog synthesizer, converting chromatograph readings into sounds in the range of a grand piano. In a chromatograph, every component of a chemical mixture is recorded as a series of peaks. In the sound version, "the low peaks are low notes and big peaks are high notes," Sweeley explains. The duration of each note, corresponding to the width of each peak, reveals the concentration of a component. In theory, an otherwise preoccupied lab technician would perk up at the sound of an abnormal peak.

There's a catch, as Sweeley points out. Although the "music" of a chromatograph is "surprisingly melodic" in places, it is atonal, and memorizing an unusual sequence of notes is difficult. "But everyone knows exactly the sequence of notes in a popular song," says Sweeley. So his lab is collaborating with the music department to assign the notes of popular songs to peaks in a standard chromatographic profile. "If any peak is out of range," Sweeley suggests, "that would sound as a sour note."

Sweeley envisions doctors laboring in an operating room to the tune of a patient's heartbeat instead of having to watch a cardiac monitor. According to Mark Sullivan, a musician who is collaborating with Sweeley, a simple way to make this possible would be to tie a song's rhythm to the heartbeat. When the heartbeat would speed up, so would the rhythm. Blood pressure could be translated into the melody of the song.

Things would get complicated if the song were to reflect changes in more parameters of the circulatory system. Every parameter would correspond to a separate aspect of a song. Rhythm, pitch, volume, and various instruments could each reflect part of a body's normal functioning.

Sullivan is convinced that he can convert something as complicated as a metabolic profile—the chemical substances produced by the body's breakdown and rearrangement of fats, carbohydrates, and proteins—into an orchestral score. "It would sound quite unlike anything you've ever heard before," Sweeley muses. □

MARC KUSINITZ is a free-lance science writer specializing in medical technology.

Forest Politics

In 1979, the U.S. Forest Service announced programs to manage the natural resources in many of the 156 national forests. As mandated by the 1976 National Forest Management Act, the plans are intended to balance resource consumption with resource protection "in a way that maximizes long-term net public benefits in an environmentally sound manner."

That goal has proved difficult to attain, and 52 of the 57 plans completed by November 1986 have been appealed through the Forest Service and the courts. The challenges cite significant increases in timber cutting, grazing, and road building, plus a relatively passive approach to protecting watersheds and to recreational, cultural, and wildlife programs.

By contrast to court challenges, the plan for New Mexico's 1.6-million-acre Cibola National Forest has been implemented after a year and a half of difficult but fruitful negotiations. Citizen groups have worked around the appeals process and achieved substantial changes in the plan in cooperation with the Forest Service. The result has been a workable compromise instead of lengthy conflict. Moreover, the timber companies and resort developers that often are at odds with the local citizens have accepted the compromise.

A Cooperative Solution

The Forest Service's 50-year plan for the Cibola Forest attracted criticism as soon as it

PHOTO: JOHN C. PHILLIPS


The Clinical Spectrum

The Clinical Spectrum

Medical diagnoses sometimes depend on the ability to trace or detect minute amounts of biological species. Now researchers at the General Motors Research Laboratories have developed a method of spectrometry using a tunable diode laser that could lead to simpler, less costly, non-invasive diagnostic techniques.

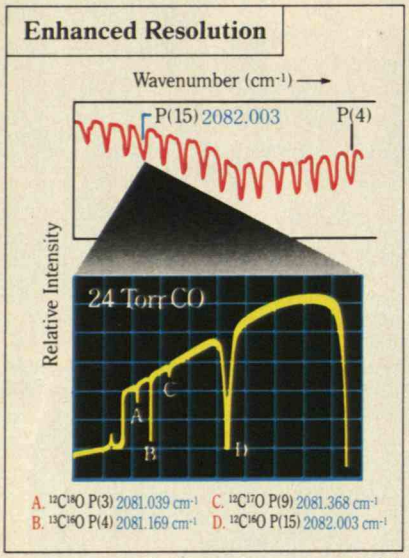
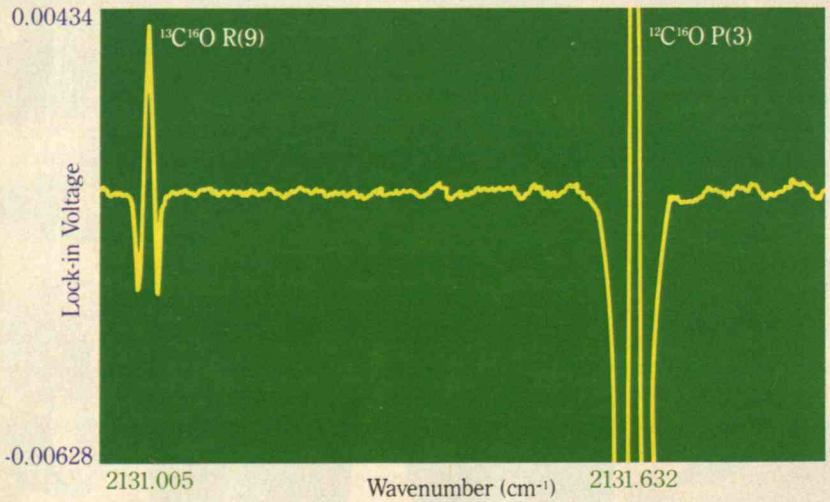


Figure 1: (Top) The absorption spectrum of CO obtained with a conventional spectrometer showing the P series rotation-vibration transitions separated by about 4 cm⁻¹. (Bottom) The diode laser spectrum centered at $^{12}C^{16}O$ P(15) region showing the complete resolution of $^{12}C^{17}O$ P(9), $^{12}C^{18}O$ P(3) and $^{13}C^{16}O$ P(4) transitions.

Figure 2: The second harmonic detection of the $^{13}C^{16}O$ and $^{12}C^{16}O$ as naturally present in exhaled human breath.



Carbon monoxide in exhaled human breath.
The scale has been expanded to show the excellent signal-to-noise ratio for $^{13}C^{16}O$. Other than removal of water vapor, no specific sample preparation or separation was needed.

In the process of living and growing, the body routinely takes in chemicals in the air we breathe and the food we eat, uses them, and converts them into other chemicals. These chemical activities, therefore, are often very good indicators of the health of the body or of its individual systems. The detection and measurement of particular chemical species is also of value in environmental, scientific and engineering studies.

Radioactive isotopes of elements in these chemicals have been extensively used as tracers. Many investigations, however, preclude their use either because no suitable radioisotope is available, or because radiation exposure raises health or environmental concerns.

The use of stable, non-radioactive isotopes for detection and tracing predates that of radioisotopes. But routine application of stable isotopes has been hindered by the lack of a detection method as versatile and simple as the scintillation counting used for radioisotopes. Mass spectrometry is the traditional method of detection of stable isotopes, but it requires extensive sample preparation, expensive equipment, and a highly trained operator to distinguish and measure chemically different molecules of the same nominal mass—nitrogen gas $^{14}N^{14}N$ and carbon monoxide $^{12}C^{16}O$, for example.

It was this need for high resolution and greater versatility that prompted Dr. Peter S. Lee and Richard F. Majkowski to develop a system for stable isotopic tracer analysis based on the molecular absorption of infrared light. A tunable, single-mode diode laser, developed originally by the Physics Department of the General Motors Research Laboratories to measure automobile exhaust gases, was used as the IR emitting source in what has proved to be a remarkably sensitive spectrometer.

The infrared absorption spectrum of molecules normally consists of transitions between series of vibration-rotation energy levels. When an atom in a molecule is replaced by an isotope of the same element, there is a shift in the energy levels due to a change in mass. The resulting frequency shift in the transitions forms the basis of the laser spectroscopic analysis system.

In the case of carbon monoxide, for example, there are six possible forms of the molecule involving stable isotopes: $^{12}C^{16}O$, $^{12}C^{17}O$, $^{12}C^{18}O$, $^{13}C^{16}O$, $^{13}C^{17}O$, and $^{13}C^{18}O$. Consequently, there would be six sets of overlapping spectral lines. Within a region of 1 cm⁻¹, there can be lines from several isotopic molecules, with as little as 0.1 cm⁻¹ or

less between adjacent lines.

This adjacency presents no problem for a diode laser system. The spectral resolution (the laser linewidth) is typically better than 10^{-4} cm^{-1}, which is orders of magnitude less than the isotopic line spacings. Since the diode laser is tunable, it can be centered in a region where the absorption lines of several isotopic molecules can be scanned within a single longitudinal laser mode (Figure 1).

In the initial experimental system, the source of the monochromatic IR radiation was a diode laser, made out of a single crystal containing layers of doped lead telluride and a lead-europium-selenium-telluride alloy. The IR light was collimated through a cell containing the sample to be studied and then focused onto an IR detector.

The cell was designed to have two optical path lengths that can be varied so that isotopic molecules with vastly different abundances can be determined from the measurement of the incident and transmitted laser intensities. U.S. Patent 4,684,805 covers this spectroscopic detection system.

The laser system can be made extremely sensitive using wavelength modulation and harmonic detection. Figure 2 shows the detection of $^{13}C^{16}O$ in exhaled human breath, where $^{13}C^{16}O$ is naturally present at a typical level of 1 to 10 parts per 100 million.

The present system can be used to measure stable oxygen isotopes in biological and organic samples that can be converted into CO. However, the method is applicable to any sample that can be converted into a gas with a suitable IR absorption spectrum.

"The use of radioisotopes as tracers is already well established," says Dr. Lee. "The potential is just as great for stable isotopes if more versatile analytical methods are made readily accessible.

"Packaged as a simpler, relatively inexpensive instrument, a tunable laser IR system could be adapted to many clinical tests—for fat malabsorption, ileal dysfunction, small-intestine bacterial overgrowth, alcoholic cirrhosis and liver function, lung function, nutritional assessment, and diabetes, to name a few.

"Diabetes could be diagnosed from the lung exhalate of a subject who had been fed a stable isotopically tagged sugar sample. No taking blood, no long waits, no radiation health and safety concerns.

"Simpler isotopic tracer measurements could broaden the scope of tracer methodologies, could supplement some of the radioisotope studies now common, and could have significant economic implications."

General Motors

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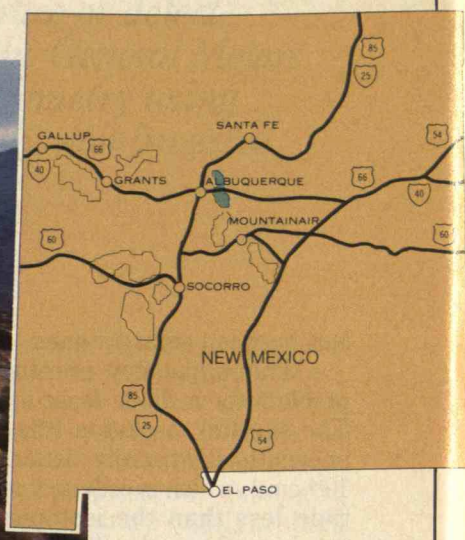
THE MEN BEHIND THE WORK

Dr. Peter S. Lee (right) is a Senior Staff Research Scientist in the Biomedical Science Department at the General Motors Research Laboratories. He received his undergraduate degree in Chemistry from the National Taiwan University. Dr. Lee also holds a Ph.D. in Physical Chemistry from the University of Illinois at Urbana-Champaign. His current research interests at GMRL include the study of biosensors and laser spectroscopy along with his work in stable isotopes. Dr. Lee came to GM in 1977 from the University of Illinois Medical Center in Chicago.

Richard F. Majkowski was, at the time of the work described here, a Staff Research Scientist in the GMRL Physics Department. Both his B.S. and M.S. degrees are from the University of Detroit in Physics and Mathematics. His research interests have included emission spectroscopy, coherent optics, holography and laser spectroscopy. Dick joined General Motors Research Laboratories in 1955 and retired in September, 1987, to become a Professor of Physics at Lawrence Institute of Technology.

The program to manage the Cibola National Forest near Albuquerque, N. Mex., includes significant citizen participation.





was released in the summer of 1985. One of the plan's most startling features, especially to citizen groups, was its proposal to increase timber sales by 300 percent in the second of five 10-year periods. Another problem was that the plan didn't show how escalating timber sales would affect watersheds, wildlife, soil protection, and recreational and cultural activities.

Indians and Hispanics with land grants dating from as long ago as the seventeenth century were also unhappy with the plan. They felt the Forest Service hadn't consulted them. In particular, they said the service hadn't detailed the effects of two proposed ski areas in mountains sacred to their cultures.

The month after it was released, the plan was formally appealed to the chief of the forest service by a coalition—including the local Sierra Club chapter, the Southwest Research and Information Center, the American Indian Environmental Council, and the Tonantzin Land Institute, which represents Hispanic and Indian land-grant communities. The groups' primary goal was not to win their appeal, which could have resulted in another unsatisfactory plan written by the Forest Service. Rather, they wanted to work with the Forest Service in revising the document. The Forest Service, which wanted to avoid having it rejected by the courts, shared the coalition's desire to negotiate.

Working with a mediator through most of 1986, the Forest Service and the coalition hammered out a 40-page amendment to the Cibola Forest plan. Adopted in January 1987, it deletes references to the high levels of timber removal that were orginally slated to occur after 10 to 15 years. In addition, it delays consideration of plans for ski developments until at least the second period of the plan. The amendment also articulates the concerns of Native Americans and Hispanics and increases protection of cultural resources.

The amendment provides for broad, continuing public participation in Cibola Forest management. The Forest Service has agreed to produce detailed accounts of monitoring and to summarize key developments through an annual report and public meeting. Since the amended plan has been adopted, the former appellants have been doing research for an environmental impact statement covering development in Las Huertas Canyon.

In agreeing on the amendment, the parties have established ways to deal with unresolved issues, such as the yearly allowable volume of timber sales. In the first timber sale discussed after the amendment, the Forest Service reduced the proposed volume by 1.7 million board feet and eliminated approximately 1,000 acres of semi-primitive land from the sale area. Both changes reflected concerns raised by citizen groups. In return, the groups gave up their insistence on further reducing timber cutting and road building in the first 10 years of the plan.

The timber-sale discussions have also prompted "show me" trips to sale areas before harvest plans have been made final. On the trips, Indian groups concerned about damage to religious sites, Hispanics concerned about damage to their lands, and conservation groups have commented on specific places designated for protection or cutting. As a result, timber cutting is being reduced on a local basis.

The Cibola is a small forest, particularly in its timber-harvest potential. Determining whether the Forest Service can repeat the Cibola experiment elsewhere will be a piecemeal process. The government will need to understand the range of citizen interests, while citizen groups will need to understand the range of interests the Forest Service works with. □

WILLIAM PAUL ROBINSON is director of the public lands and resources project of the Southwest Research and Information Center, Albuquerque, N. Mex.

PHOTO AND MAP: CIBOLA NATIONAL FOREST





FAT CITY

Discouraged with dieting? Sick of exercise? Your ideal body is now available—with surgery. Try liposuction, a technique that uses a vacuum pump to suck fat out of the thighs, abdomen, or face. Liposuction is the most popular form of aesthetic surgery in the United States, reports the American Society of Plastic and Reconstructive Surgeons. Double chins and laugh lines are particular targets for "sculpting."

Unfortunately, liposuction has been linked to deaths and complications resulting from blood or fat clots blocking vessels that feed the heart, brain, or lungs. Part of the problem is that physicians are not required to undergo special training before performing liposuction procedures.

Some patients elect to transplant their fat rather than throw it away—to counteract wrinkles and enlarge breasts, for example. The reinserted fat usually shrinks, so the technique must be repeated to maintain results.

SINGING SATELLITE

The French satellite *Fugue* will carry a synthesizer that celestial musicians will "play" on. The synthesizer, designed by musician Philippe Guerre, will make music from the radio signals that the sun and other stars emit. Slated to be put into orbit in 1991 by France's *Ariane* rocket, *Fugue* should broadcast to the listening public every evening for five years.

COAL BUGS

Researchers are growing genetically engineered bugs that could make coal a cleaner source of energy and easier to use.

Experiments in the early 1980s turned up a common wood-rot fungus that can liquify lignite coal. In 1986 Electric Power Research Institute (EPRI) scientists isolated a key enzyme—produced by the fungus—that dramatically speeds up the process. Studies are under way on liquifying coal underground so that it could be pumped to the surface like oil.

Other researchers are seeking bacteria that may remove pollution-causing sulfur from coal. According to EPRI, sulfur removal may turn out to be the first way that bioprocessing is applied in the coal industry. Treating coal in a bacterial broth has been shown to double the amount of "pyritic" sulfur—the kind that exists in distinct veins or nodules and therefore can be removed by conventional cleaning.

Sometimes, however, over half the sulfur is bound into coal molecules so that this process cannot remove it. A new genetically altered bug removes such sulfur by breaking down the molecules' chemical bonds.

DAM SITE SMARTER

Dams look inert, but they are always changing in subtle ways. Experts like Tom Kelly, senior civil engineer at Southern California Edison (SCE), can spot changes before a serious threat develops. Working with SCE "knowledge engineers" and Texas Instruments, Kelly is creating an expert computer system that could draw on his experience to produce recommendations similar to his own. Kelly has watched over SCE's 32 dams for 21 years, and has prescribed most of the corrective maintenance performed on them.

At its present stage, the Kelly system, as it is called, already carries out a number of functions. A set of highly detailed graphic cross sections depicts each dam, including its monitors. The system also contains written accounts of significant incidents and complete histories of monitor readings. The computer checks new data and alerts Kelly if its "rule base" indicates a problem. Another rule base helps diagnose the problem's cause and suggests cures.

R&D DANGERS

An American Society of Mechanical Engineers (ASME) policy statement charges that "one of the greatest threats now facing the continued vitality of corporate innovation and technology development and application is the ongoing process of restructuring within American industry forced by hostile takeovers."



According to the ASME, "the manufacturing sector has been particularly hard hit by hostile takeovers." The report blames "the relatively low valuation placed on many manufacturing firms by Wall Street combined with very difficult economic times" and says that the "present dedication to short-term profitability brought on by hostile takeover activities has had a strong negative impact on industrial research and development in the United States."

The statement concludes that reduced industrial R&D after a hostile takeover "jeopardizes our technology base for the future, reduces our global competitiveness, and results in displacement or unemployment of many engineers and scientists."

EVOLUTION & VIRUSES

Can disease cause evolution? In *Chemtech*, retired management engineer Stanley Henrici writes that "recurrent epidemics of reproductive-cell diseases sculpted the DNA that bred man." Henrici refers to Darwin, who in turn quotes from a "celebrated geologist, Count Keyserling." Says the count, "the germs [reproductive cells] of existing species may have been chemically affected by circumambient molecules" such as viruses and "thus have given rise to new forms."

Henrici notes that "evolutionary science says much about the results of mutation and little about causes. Radiation, chemicals, and spontaneous exchanges of genes . . . are mentioned," but he believes that viruses are the only logical way that uniform mass mutations could have occurred. "They could quickly have created wholly new forms of life . . . in a single, ordinary fleeting month."

ILLUSTRATIONS: JON MCINTOSH

SAMUEL C. FLORMAN

Anonymous Heroes

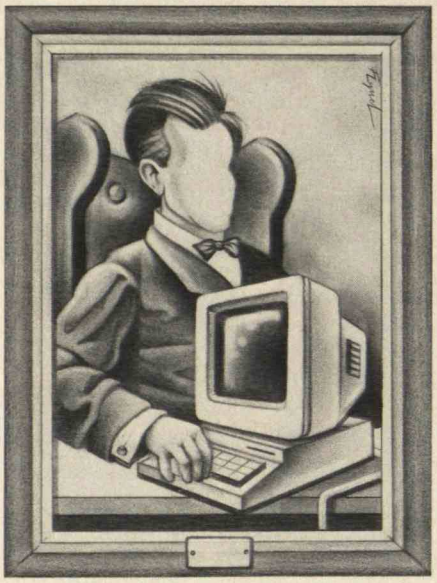
WHO invented the integrated circuit—the microchip—that launched the electronics revolution and heralded the coming of a new age? I ask the question rhetorically to make the point that hardly anybody knows the answer. It is a truism that scientists and engineers rank low in public recognition. The celebrities of our culture are entertainers, newscasters, politicians, or the occasional business executive.

We are so accustomed to this state of affairs that we hardly pause to wonder why it exists. Yet the public obscurity surrounding the inventors of the integrated circuit—and other notable technologists—is a phenomenon that demands scrutiny.

On July 24, 1958, Jack Kilby, an engineer newly hired at Texas Instruments in Dallas, wrote in his lab notebook what came to be known as The Monolithic Idea: "The following circuit elements could be made on a single slice: resistors, capacitor, distributed capacitor, transistor." Kilby's insight—that all the elements of an electronic circuit could be fashioned out of the same piece of silicon—was, in retrospect, an exquisitely simple idea. At the time, however, silicon was not deemed a suitable material for a resistor (carbon was the standard) or a capacitor (a combination of metal and porcelain was better). So Kilby's Monolithic Idea was truly a conceptual breakthrough.

In January of the following year, Robert Noyce, a physicist at Fairchild's recently formed Semiconductor Division in Silicon Valley, described in his notebook the main elements of the integrated circuit. His insight, although it came slightly later than Kilby's, was more complete. Whereas Kilby had failed to solve the problem of interconnecting the various components of the integrated circuit (in his first models, this was done by means of tiny gold wires inserted by hand), Noyce envisioned using metal strips stamped into an oxide layer on the surface of the chip itself.

A 10-year court fight over patent priority was eventually won by Noyce, but there is wide agreement in the scientific and engineering community that the two men deserve joint credit for inventing the integrated circuit. Both were awarded the National Medal of Science, both were inducted into the National Inventors' Hall of Fame, and both have benefited financially from their work, although Noyce more so because he was a principal at Fairchild. He went on to make a substantial fortune as a founder of Intel Corp.



Are we so jaded with technology that we ignore those who create it?

The worldwide social and political consequences of what these two men accomplished—nothing less than a second Industrial Revolution—are demonstrated around us each day. And yet, practically nobody knows their names. I ask people all the time—including people I expect would know the answer—and invariably I am greeted with a blank stare.

This is all the more remarkable when one considers that Thomas Edison, after he perfected the light bulb, was arguably the best-known person in the world. At the age of 75, long past his years of productive work, he still ranked as the "most admired American," according to a *New York Times* survey. Alexander Graham Bell and Henry Ford also became cultural heroes, as did many other inventors and industrialists of the past.

What has changed? Why are the greatest technologists of our time so shrouded in anonymity? I have posed this question to the same people who fail to identify Kilby and Noyce, and their answers fall into several categories.

First, there is the matter of personality. Edison was a grand eccentric, some claim, whereas today's inventors are a bland lot who carry pocket calculators and fade into the woodwork. True, Kilby (who, by the way, headed the team that *invented* the pocket calculator) is a quiet, unassuming engineer, happiest working alone in his laboratory. Noyce, however, is a successful entrepreneur and leading spokesperson for the semiconductor industry (his associates call him "the Mayor of Silicon Valley"). He shares a special spotlight with such flamboyant businessmen-technologists as Steven Jobs, H. Ross Perot, and David Packard.

But even these heroes of the marketplace have not achieved more than a fraction of the fame accorded the likes of Edison, Bell, and Ford. No, personality is not the key to the problem. Neither is wealth: Packard is one of the 10 richest Americans.

Nor does the explanation lie, as others suggest, in the collective nature of contemporary engineering. Admittedly, large anonymous teams inhabit the laboratories of industry, government, and academe. But all the more exciting, I suggest, are the rare feats of individual inspiration such as those of Kilby and Noyce.

Some of my respondents see the problem as one of public relations, or rather its absence, in a too-modest scientific and engineering community. More TV exposure would help, to be sure, but one must agree with those media people who say that their lack of interest in technologists is an effect of the prevailing situation rather than its cause.

Of course, technology itself has changed since Edison's time, and some observers profess to find new inventions less enchanting than old ones. Light bulbs, suspension bridges, and automobiles, so goes this theory, can be "comprehended" by the public, qualifying their inventors for membership in the human pantheon. Integrated circuits, on the other hand, are "black box" phenomena that few really

Continued on page 78



SAMUEL C. FLORMAN, A CIVIL ENGINEER, IS THE AUTHOR OF ENGINEERING AND THE LIBERAL ARTS, THE EXISTENTIAL PLEASURES OF ENGINEERING, BLAMING TECHNOLOGY, *AND* THE CIVILIZED ENGINEER.

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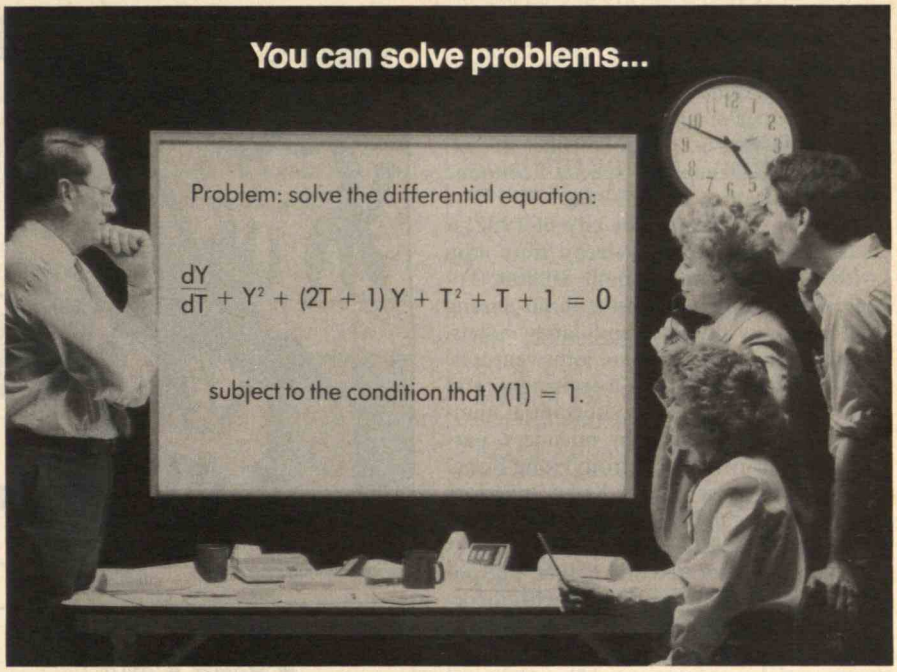
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(C2) DIFF(Y,T)+Y^2+(2*T+1)*Y+T^2+T+1;
```

$$(D2) \quad \frac{dY}{dT} + Y^2 + (2T+1)Y + T^2 + T + 1$$

```
(C3) SOLN:ODE(D2,Y,T);
```

$$(D3) \quad Y = -\frac{\%C\,T\,\%E^T - T - 1}{\%C\,\%E^T - 1}$$

```
(C4) SOLVE(SUBST([Y=1,T=1],D3),%C),NUMER;
(D4)    [%C = 0.5518192]
(C5) SPECIFIC_SOLN:SUBST(D4,SOLN);
```

$$(D5) \quad Y = -\frac{0.5518192\,T\,\%E^T - T - 1}{0.5518192\,\%E^T - 1}$$

and Numerically.

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(C6) FORTRAN(D5)$
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     1         /(0.5518192*EXP(T)-1)
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MARSHALL I. GOLDMAN

China's Apprenticeship in the World Economy

THE debate over whether China can repeat the economic success of other East Asian countries, such as Japan and South Korea, will not be resolved soon. For one possible scenario for China's future, however, consider the example of Shenzhen, the Special Economic Zone adjacent to Hong Kong.

When I first visited the city in 1982, it was little more than a sleepy train stop with a population of about 30,000. Today, 500,000 people bustle about among factories, skyscrapers, and fancy hotels. Many of these facilities are joint ventures, partnerships between foreigners and mainland Chinese. But a substantial number are wholly owned by outsiders, particularly businesspeople from Hong Kong.

Some of these Hong Kong investors spend restless nights fretting about what will happen in 1997 when Hong Kong is formally incorporated into China. The political uncertainties associated with incorporation certainly give ample cause for worry. For the time being, however, it appears as if the region around Shenzhen and nearby Canton is being absorbed into Hong Kong rather than vice versa. The whole region seems on the verge of becoming an integrated (albeit, loosely) whole—with the headquarters in Hong Kong and the workshops stretched across the frontier as far north as Canton.

The economies of Hong Kong and the Chinese border areas are perfectly suited to each other. For Hong Kong, China is the answer to a growing labor and space shortage. For China, Hong Kong represents the fast track to technology transfer and the promotion of Chinese exports.

By using the Chinese hinterland, Hong Kong entrepreneurs have been able to transcend the limitations imposed by their own small territory. Neighboring China allows them to expand the scope of their operations, as if they lived in the major city of a large industrial region. Investment in Shenzhen also provides Hong Kong firms with access to a new low-skill, low-wage work force, a crucial resource as low unemployment and rising expectations cause wages in Hong Kong to mount.



***Hong Kong** business expertise and Chinese labor may yield Asia's next success story.*

Chinese workers demand only about a quarter to a third of the going Hong Kong wage. Admittedly, in the first years of operation, productivity in a new mainland factory may be only 30 to 50 percent of that in Hong Kong. However, according to one factory manager I visited in late summer, after five years his employees in Shenzhen are now more productive than their counterparts in Hong Kong—even if one sets aside the large wage differential. One reason is that his Chinese workers are willing to work ten-hour days, six days a week, largely because they are paid in Hong Kong currency for the extra two hours of work each day.

Another reason for high productivity in the Shenzhen plants is that employers have their pick of China's work force. Workers are recruited from all over the country for jobs in the Special Economic Zone. In a toy factory I visited, the Chinese entrepreneur had hired only young women, whereas in Hong Kong the low wages of the facility and the availability of better jobs elsewhere would have limited him to less efficient older workers.

But what about the Chinese? Is the rapid economic development in Shenzhen good for them? There is no question that many, if not most, of the factories being set up in places like Shenzhen, particularly by the Hong Kong business community, are sweatshops. The work is hard and monotonous, the hours are long, and the workplace is crowded, dirty, and hot. Inevitably, the visitor begins to wonder what Mao Zedong would say if, by some quirk of historical fate, he were able to make a surprise visit to one of these factories. No doubt he would view it as a betrayal of his Marxist revolution.

And yet there are important benefits for China in the current arrangement, vindicating the pragmatism of Deng over the ideological purity of Mao. In effect, Hong Kong managers are teaching Chinese managers and workers the methods, techniques, and discipline necessary to compete in the world economy. That is something China desperately needs. Such on-the-job training is considerably more effective than the theoretical training that comes from textbooks and classrooms.

In short, the Chinese are gaining extremely valuable experience in Shenzhen by watching how Hong Kong businesses operate. And although it is hard for a visitor to know for sure, one has the impression that many of the workers in the Shenzhen plants understand this. True, the hours are long and the work unpleasant, but the workers are also proud of the amenities their wages bring them for the first time in their lives. What's more, each year they are mastering new techniques that make possible the production of ever more sophisticated and higher-value goods.

Indeed, the similarity with what happened in Japan 35 years ago and in Korea and Taiwan 15 years ago is striking. The Hong Kong investors may someday pull up their neighbors in China to the point where they will be able to play the same role for the rest of the country—in this instance using Canton as the headquarters. Having built upon their sweat, the Chinese of Shenzhen will then move on to more complex, less onerous, and higher-paid forms of work. □



MARSHALL I. GOLDMAN IS PROFESSOR OF ECONOMICS AT WELLESLEY COLLEGE AND ASSOCIATE DIRECTOR OF THE RUSSIAN RESEARCH CENTER AT HARVARD UNIVERSITY. HE IS THE AUTHOR OF GORBACHEV'S CHALLENGE: ECONOMIC REFORM IN THE AGE OF HIGH TECHNOLOGY *(W. W. NORTON, MAY, 1987).*

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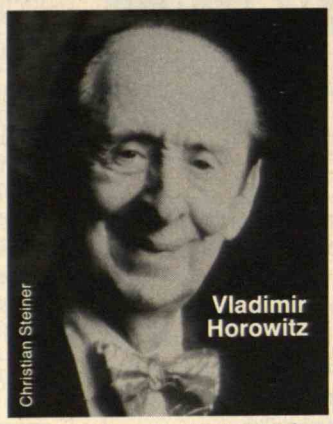
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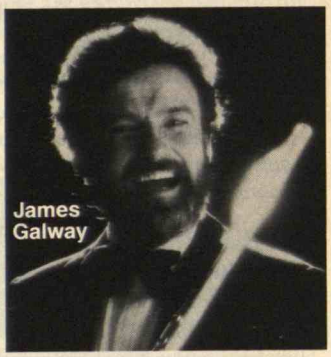
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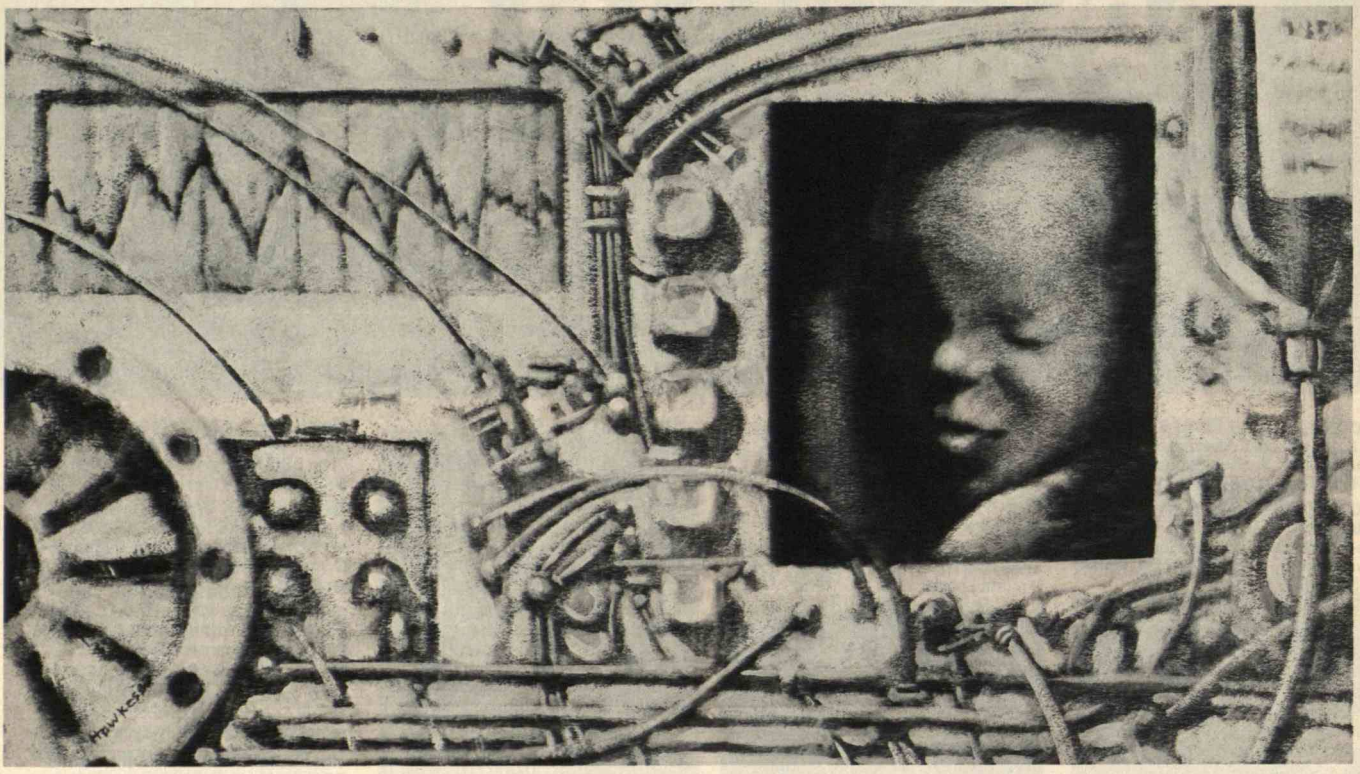
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BY KATHY FACKELMANN

Children Who Need Technology – and Parents



TECHNOLOGY saved five-year-old Natasha Herndon's life but keeps her dependent on a mechanical respirator in a St. Louis hospital. Natasha, born prematurely with underdeveloped lungs, is one of the children who medical professionals call "prisoners of technology." As doctors save more premature and underweight infants, increasing numbers of children are growing up in hospital wards. Often abandoned by frustrated parents, these youngsters have no semblance of a real home because of a severe shortage of foster care and pediatric facilities.

In 1960, 3 of 10 very low birthweight babies—those weighing 3.3 pounds or less—survived at least a month. Physicians now save more than twice that number, according to the Office of Technology Assessment (OTA). But because of medical advances, OTA estimates that 17,000 American children need respirators or depend on intravenous nutrition or medication. Another 30,000 need kidney dialysis or other mechanical help.

KATHY FACKELMANN is editor of "Perspectives," a regular feature in Medicine & Health, *a Washington, D.C.-based health-policy newsletter.*

> ***S**ociety must provide for the abandoned children who depend on advanced medical technology.*

Parents do not receive enough aid from the government and, when available, from private insurers to care for their "million-dollar" babies. Not all parents are willing or able to pay for expensive home renovations and to take on the sophisticated nursing duties that may be needed round-the-clock.

Natasha, for example, lives at Cardinal Glennon Children's Hospital. At first, her teenage parents visited sporadically, but later they deserted her. Today, "she gets a new momma every eight hours," says hospital spokesman Joseph Costantino.

Teenage parents such as Natasha's are more likely to leave their children in the hospital. And because they often don't seek early medical attention, teens are more prone than adults to give birth to underweight infants plagued with medical problems.

Poor women, who have a harder time obtaining proper medical advice, are also at higher risk of bearing children with serious disorders. Some 63 percent of low-income women do not obtain sufficient prenatal care, according to a recent report by the U.S. General Accounting Office (GAO).

Once parents leave their technology-dependent children in hospitals, chances are strong that no one else will take the youngsters in. There aren't enough foster parents to go around. From 1977 to 1984, the number of foster families nationwide dropped from almost 600,000 to less than 200,000. And most foster parents shun technology-dependent children because of the medical care they require. Even if social workers can find families willing to adopt children, they aren't covered by many family medical insurance policies.

Moreover, the few group homes that accept ventilator-dependent adults don't

ILLUSTRATION: KEVIN HAWKES

receive children. OTA reports that only New Jersey and Ohio have skilled nursing homes that take in children needing respirators. Only a few states have any pediatric nursing homes.

Most of these children are therefore stranded in hospitals—and the hospitals are stuck with their bills. For instance, Natasha has cost Cardinal Glennon $2 million since her admission four years ago. After Natasha's parents relinquished custody, Medicaid began to pitch in—but the plan doesn't cover the entire bill. Payment shortfalls for several children like Natasha have cost Cardinal Glennon $4.5 million during the past five years. "Morally, we have an obligation to keep them in our care," says Douglas Ries, executive director of the facility. "But financially it is becoming a tremendous burden."

Not all hospitals are likely to play the role of Robin Hood in today's competitive health-care marketplace. Some might dump these children on families that can't safely care for them, OTA warns. This would increase the potential for abuse or negligence—even if the parents received the necessary medical apparatus and financial assistance.

Government Attempts to Help

The federal government is starting to address the problems of these children. A task force on technology-dependent children will send a report with recommendations to Congress in April. And Sen. John Chafee (R-R.I.) has introduced legislation to provide catastrophic health insurance to newborns whose hospital bills exceed $50,000 their first year. Chafee's bill would help an estimated 9,600 families with severely ill newborns, at an annual cost of $500 million.

Sen. Dave Durenberger (R-Minn.) has introduced legislation that would expand Medicaid coverage to chronically ill children from low-income families. The plan would also pay for children such as Natasha who don't have families. Durenberger's measure—the cost of which has not yet been determined—would allow states to make sure youngsters receive community home care so that more costly hospitalization would be avoided.

Right now, many states won't pay for care provided outside the hospital, even though health-policy experts say non-hospital care can be cheaper. Often state officials are reluctant to step in because they expect that expanding coverage to non-hospital settings would increase strained Medicaid budgets. Costs could increase, some officials worry, because families who now provide care to children at home without assistance would then be eligible for Medicaid.

Any attempts to expand government health programs will probably meet with resistance as federal lawmakers work to reduce the national deficit. But at the least, the federal government should provide start-up funds for a demonstration project to find out if transferring children to group homes with some live-in staff would save money and improve their well-being. Such projects have provided significant results before. For instance, the nation's Medicare program adopted the DRG payment system for hospital costs after Yale University ran a federally funded, money-saving demonstration project in New Haven in the 1970s.

Organizations such as the Robert Wood Johnson Foundation, a well-known donor to medical causes, could also sponsor group homes. Even community and church leaders could try to convince state Medicaid officials of the value of using funds for group homes and foster family care rather than hospitalization.

In addition to helping children who need elaborate medical technology, Americans must support family-planning programs. The Reagan administration has tried to chip away as much as 40 percent of the funds allocated to the national family-planning program, Title X, which provides sex education and contraceptive services to 4.3 million low-income women. While Congress has consistently fought off the administration's attempts, the threat to Title X will not subside as long as the public is convinced that the program is pushing abortion and teenage sex.

In fact, more sex education services and wider access to birth control are needed to help decrease the high teen birth rate. More than 1 million teens become pregnant each year in the United States.

Better prenatal-care programs are also important. Although Congress has urged states to revamp Medicaid to cover more low-income pregnant women, many have not set up programs for all women living at or below the poverty line. Sen. Bill Bradley (D-N.J.) and Rep. Henry Waxman (D-Calif.) have introduced bills to help Medicaid cover more low-income pregnant women. These women should also receive free transportation to clinics or doctors if they need it, and, according to the GAO, better education about the importance of nutrition and medical attention early in a pregnancy.

The increased costs of expanded prenatal Medicaid programs would be offset by the reduced need to support underweight babies in intensive-care units. According to the National Academy of Science's Institute of Medicine, for every dollar spent on prenatal care, more than three dollars are saved in the reduced cost of caring for low-birthweight infants.

Whatever the cost, a society that has decided to support advances in medical technology must foot the bill for the needy children that result. Kids forced to grow up in the impersonal halls of a hospital often fail to thrive. No one likes to think about such abandoned children, but until we take responsibility for them, youngsters such as Natasha will wait in their hospital beds. □

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We could soon target warheads for intercontinental missiles far more precisely. We need a ban on flight tests to stop this dangerous development.

The Next Nuclear Offensive

BY MATTHEW BUNN

THE year 1968 witnessed the beginning of a revolution in missile technology: the testing of U.S. multiple-warhead ballistic missiles. In the first strategic arms limitations talks (SALT I), which began the following year, neither superpower had the foresight to press seriously for a ban on these missiles. The United States wanted to preserve its lead, while the Soviets were anxious to catch up. In the end, SALT I limited only the number of missiles, allowing a massive and dangerous buildup as missiles carrying as many as 14 warheads replaced their single-warhead predecessors. The lesson is clear. Arms control ignores technological progress at its peril.

Today, another revolutionary strategic-missile technology is under development—maneuvering reentry vehicles, or MARVs. MARVs are nuclear warheads capable of changing course as they streak through the atmosphere. The best way to see their significance is to compare them with the conventional reentry vehicles carried by our strategic, or long-range, ballistic missiles.

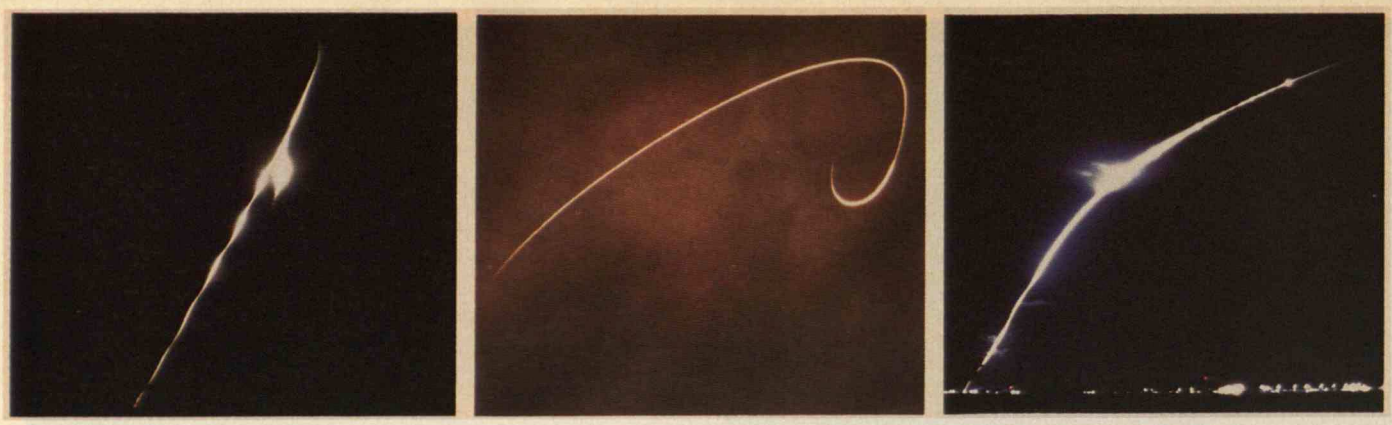
Today's reentry vehicles are simple, sleek cones concealing the intricacies of the nuclear warheads



PHOTOGRAPHS: DEPARTMENT OF DEFENSE



In the late 1960s the United States started testing ballistic missiles with multiple warheads, such as the ones shown here reentering the atmosphere. Because neither superpower pressed hard for a ban, a serious buildup ensued, increasing the risk of nuclear war. The same thing could happen today with strategic-range precision-guided warheads.



inside. They are released from a missile early in its flight and hurtle toward their targets entirely unpowered and unguided, much like cannon shells. Their trajectories are predictable, easing the task of defense missiles. And since they have no means to correct for such phenomena as winds and weather, their accuracy has fundamental limits. Indeed, the MX missile now being deployed, which carries reentry vehicles that would land on average within 100 meters of a target a quarter of the way around the earth, comes close to the ultimate accuracy practical.

MARVs change all that. Equipped with aerodynamic surfaces such as wings and flaps, and a guidance system to control their maneuvers, one type, known as evading MARVs, can dodge and swerve as they reenter the atmosphere, confounding defenses. Another type, precision-guided reentry vehicles (PGRVs), can use sophisticated sensors to home in on a target with enormous precision.

These two types of MARVs have profoundly different implications. Evading MARVs could help stabilize the nuclear balance by reinforcing existing arms agreements. Since their evasive maneuvers make effective missile defense far more difficult, they reduce the incentive for either the United States or the Soviet Union to abandon the 1972 Anti-Ballistic Missile (ABM) Treaty limiting missile defenses.

Sophisticated PGRVs, by contrast, could increase the danger of nuclear war. By making rapid "surgical" strategic strikes possible, PGRVs might increase the chance that military or political leaders would choose the option of a "limited" strategic nuclear attack in the midst of a deep crisis or conventional war. Any such attack would carry with it an enormous risk of escalation to all-out nuclear war. Moreover, other types of PGRVs might someday pose dangerous threats to critical mobile military targets such as ships at sea or command aircraft.

While the United States has already developed evading MARVs, PGRVs for strategic missiles have not yet been developed. It appears that the Soviet Union has not yet developed either type of MARV. As with multiple-warhead missiles 20 years ago, the United States has the technological lead. We should avoid making the same mistake we made then. Rather than short-sightedly pursuing the development of PGRVs, we should use our technological lead as a bargaining chip, offering to forego further MARV testing if the Soviets do the same. This would forestall the dangers posed by PGRVs and improve the security of both sides.

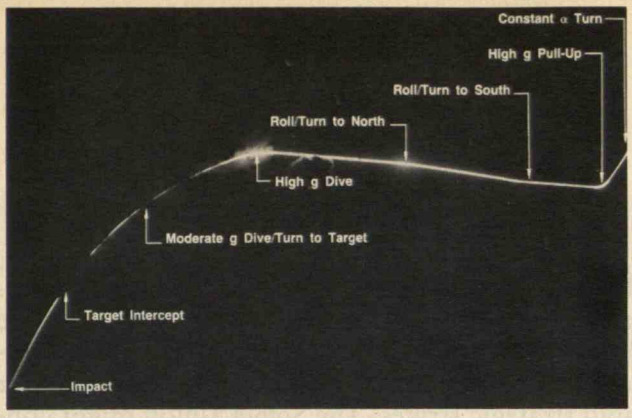
MATTHEW BUNN is a senior research analyst with the Arms Control Association.

Changing Trajectories

A closer look at MARVs suggests why the evading type has already been developed, while strategic-range PGRVs pose problems that will take some years to resolve. Evading MARVs are designed to counter "terminal" missile defenses, which attack reentry vehicles as they return to the atmosphere heading toward their targets. These defenses must "lead" the reentry vehicle, firing not at where it is but at where it will be, much as a hunter aims in front of a flying duck. But predicting a target's trajectory becomes impossible if it is executing high-acceleration zigzags. Firing interceptors at every path the MARV might take would rapidly exhaust the defense. A practical defense against evading MARVs requires interceptors capable of matching their maneuvers, chasing them down one-on-one. While feasible, such interceptors are very costly.

Of course, evasion also involves costs for the offense. MARVs are inevitably more complex than nonmaneuvering reentry vehicles—and therefore heavier, more expensive, and generally less reliable. For the first generation of evading MARVs, tested by the United States starting in 1967, the drawbacks were too great. Weighing one and a half tons, the early MARVs were too heavy for practical deployment, particularly on the multiple-warhead missiles the United States was then moving toward. These missiles carried warheads weighing only a few hundred pounds.

By the 1970s, revolutions in electronics, materials, and guidance technology made MARVs practical.



Opposite page: The navy Mark 500 underwent flight tests in the mid-1970s. It can change course to avoid missile defenses as it reenters the atmosphere. Near left: The AMaRV, another "evader," conducts maneuvers known as pull-ups, rolls, and dives.

Two effective evaders were developed—the navy Mark 500 (MK. 500) and the air force Advanced Maneuvering Reentry Vehicle (AMARV). The MK. 500 is a simple design. It has a permanently bent nose. A heavy electronics package moves inside, causing the nose to roll back and forth so that the vehicle makes wide, sweeping turns. Eight successful MK. 500 flight tests have been conducted since 1975, and a new variant, called the Maneuvering Test Vehicle, was successfully flight tested in April 1987. The other evader, AMARV, has two controllable flaps instead of a bent nose, allowing it to execute more sophisticated, precise maneuvers. Like the MK. 500, AMARV has undergone a number of successful flight tests, starting in 1980.

Both evading MARVs are now regarded as "on the shelf" technology. The United States could rapidly develop and deploy them should the Soviet Union ever begin deploying widespread defenses against U.S. missiles. "Evasion technology is pretty well in hand," according to Col. Richard René of Advanced Strategic Missile Systems (ASMS), the primary U.S. reentry-vehicle development program. Moreover, ASMS is developing yet another evading MARV. That vehicle's first flight test is scheduled for 1990 or 1991.

As mentioned, evading MARVs will likely have a favorable effect on the strategic balance. The Soviets will be less inclined to break out of the ABM Treaty, since the United States could use MARVs and other "penetration aids" such as decoy warheads and radar jammers to overcome any defenses they could deploy for many years. Indeed, Deputy Undersecretary of Defense for Strategic and Theater Nuclear Forces Lawrence Woodruff told Congress last year that current Soviet defenses could be easily overcome even without MARVs. MARVs would only be needed to defeat more "advanced threats," he said.

"Surgical" Nuclear Strikes

Altogether more hair-raising, both in their technological difficulties and strategic implications, are PGRVs. These very accurate MARVs, needing less explosive power to destroy targets and therefore minimizing unintended damage, are the weapons of choice for so-called surgical nuclear strikes in "limited" nuclear war. That is why James Schlesinger—who championed "limited nuclear options" as secretary of defense in the early 1970s—also championed a vigorous PGRV program.

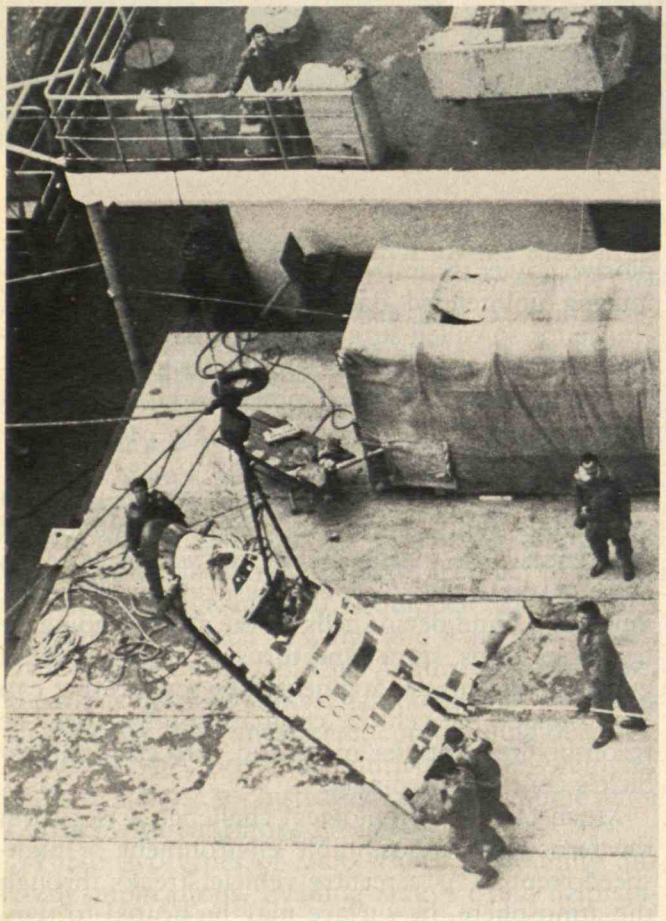
Externally, a PGRV might not differ greatly from an evading MARV, but there are vast technological differences. The inertial guidance systems used on evading MARVs rely solely on measuring acceleration, much as a blind person tells where a bus is going by feeling its stops, starts, and turns. In PGRVs, inertial guidance systems are augmented by sensors that can look outside the vehicle, comparing what they see to on-board computer maps and correcting the vehicle's course accordingly.

Much of the technological challenge arises from the ferociously inhospitable environment of high-speed reentry. As a reentry vehicle streaks through the atmosphere, its surface may be heated to temperatures well above that of boiling lead. Developing sensors that can survive and operate in such an environment—and that are small enough for a practical weapon—has proved extremely difficult. This is especially true for strategic-range PGRVs. They reenter the atmosphere much faster and are heated to far higher temperatures than shorter-range reentry vehicles. And the need to carry strategic-range warheads further puts a much greater premium on light weight.

The only PGRVs that have been developed are for the intermediate-range Pershing IIs now deployed in Europe. First successfully flight tested in 1978, the Pershing II PGRV uses an on-board radar to scan the territory below as it dives toward its target, comparing what it sees with computer maps compiled from satellite imagery. Weapons experts estimate that the reentry vehicle could carry its roughly 40-kiloton nuclear warhead to within 40 meters of its target.

Work on strategic-range PGRVs has been under

The object the Soviets are recovering here is thought to be a scale model of their space plane. This craft employs the kind of maneuvering reentry technology that the Soviets could use to develop weapons comparable to ours.



way since the early 1970s. After a fallow period in the late 1970s and early 1980s, PGRV development efforts have been reinvigorated recently. ASMS now spends millions annually on PGRVs. Sensor technology is being tested on aircraft, and materials for protecting sensors are being investigated on reentry-vehicle flight tests. Tests of the first strategic-range PGRVs could begin in the early-to-mid 1990s.

PGRVs could be used for "surgical" strikes on hardened missile silos and other military targets, as well as economically critical facilities. Much of the intellectual rationale for pursuing PGRVs has been provided by nuclear strategists of the RAND Corp. Two of the most notable are alumni of RAND—Schlesinger and the hawkish nuclear analyst Albert Wohlstetter. Within the Defense Department, PGRVs' most enthusiastic supporters have been civilian officials and the ASMS office.

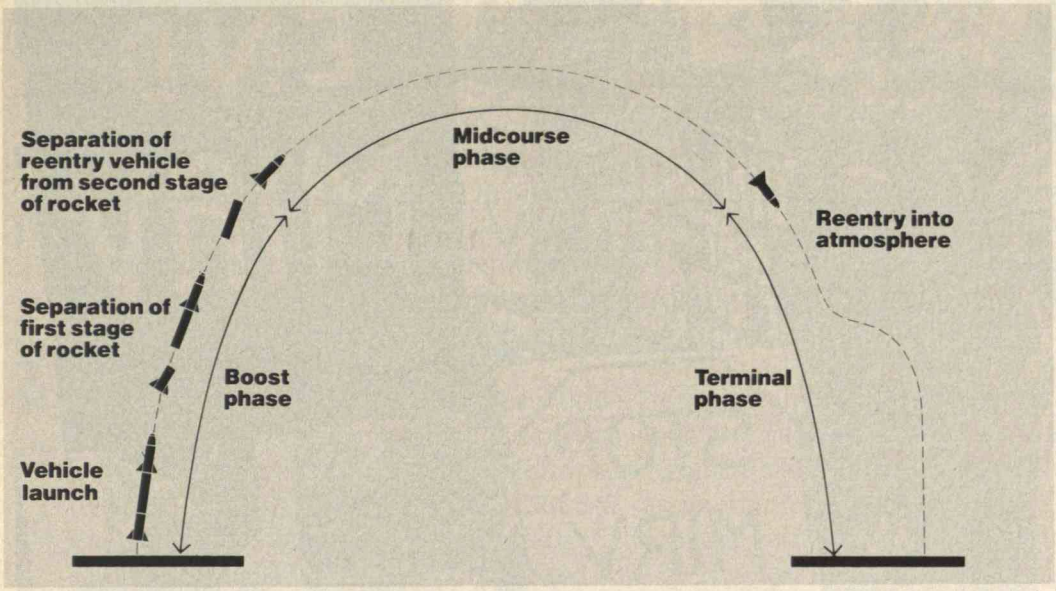
These proponents point out that smaller, more accurate warheads would cause less unintended damage, thus saving lives. Moreover, they argue, by allowing rapid "surgical" strikes, PGRVs would enhance deterrence. Without PGRVs, they say, the United States would have only large, indiscriminately destructive nuclear weapons available for rapid strategic strikes. The Soviet Union might conclude that the United States would not use such weapons in response to a conventional attack, for fear of igniting an all-out nuclear exchange. Hence the Soviets might not be deterred from such an attack. PGRVs, advocates believe, would help solve this problem by making "limited" nuclear responses more credible.

But this is precisely what worries PGRV opponents. If, in a deep crisis or conventional war, a military adviser could tell U.S. or Soviet leaders that the situation could be turned around by "surgically" destroying a few targets, might a decision to use such nuclear weapons be more likely? I believe that these weapons would increase the risk of "limited" nuclear war. And once they had been used, there would be an enormous risk of escalation to an apocalyptic, all-out exchange.

PGRV technology creates other, equally thorny problems. "Earth-penetrating" warheads, developed for the Pershing II and under study for strategic-range MARVs, would dig deep into the ground before exploding to destroy buried targets such as command-and-control bunkers.

Alternatively, PGRVs might even hunt down mobile targets. Radars would be particularly easy prey, since the reentry vehicles could simply home in on the radar signal. Radar-homing warheads have been a major focus of recent ASMS reentry-vehicle development efforts. A PGRV designed to swoop down and destroy radar aircraft used to direct air battles is reportedly under study. In the long run, aircraft-hunting PGRVs might threaten command-and-control aircraft, the most critical element of the U.S. strategic command system.

Some mobile targets might be difficult for PGRVs to find, however. Attacking the trains and trucks that carry the new mobile Soviet intercontinental ballistic missiles, for example, is likely to be an "extraordinarily demanding" task, as a recent classified Defense Science Board study reportedly concluded. PGRVs used to attack mobile missiles would need extremely sophisticated sensors and computers to find their targets, and satellites would have to watch possible targets continuously to tell the PGRVs where to look. The effort would require far more recon-



The Pershing II warhead, which uses built-in radar, can compare what it sees with stored computer maps and adjust its trajectory accordingly.

naissance satellites than are in place today, at a cost of billions of dollars. Moreover, camouflage or decoys might confuse the system.

Nevertheless, the multitude of possible uses for PGRVs raises a hornet's nest of troubling issues. The ability to strike ships within minutes anywhere on the seas could increase the risk of escalation from local conflicts to global war. Worse, new threats to command-and-control centers, whether buried bunkers or aircraft, could increase each side's incentive to launch strategic forces, for once such centers are destroyed, it could be too late to use these forces. In a future confrontation, such pressures to launch could tip the balance from severe crisis to all-out war. In short, PGRVs—particularly in Soviet hands—could create a much less secure world than the one we live in today.

Toward a MaRV Test Ban

The current status of MARV technology can be summed up simply. The United States has in hand the ability to deploy the evading MARVs that are so crucial a hedge against possible Soviet defenses. However, it has not developed the more troubling strategic PGRVs.

Unclassified information indicates that the Soviets have not yet tested a long-range MARV, although the authoritative publication *Jane's Defence Weekly* reports that they may be preparing to do so within a few years. The Soviets have tested a scale model "space plane" that incorporates the basic technologies of maneuvering reentry, but this vehicle can hardly be considered a MARV. It is not designed for

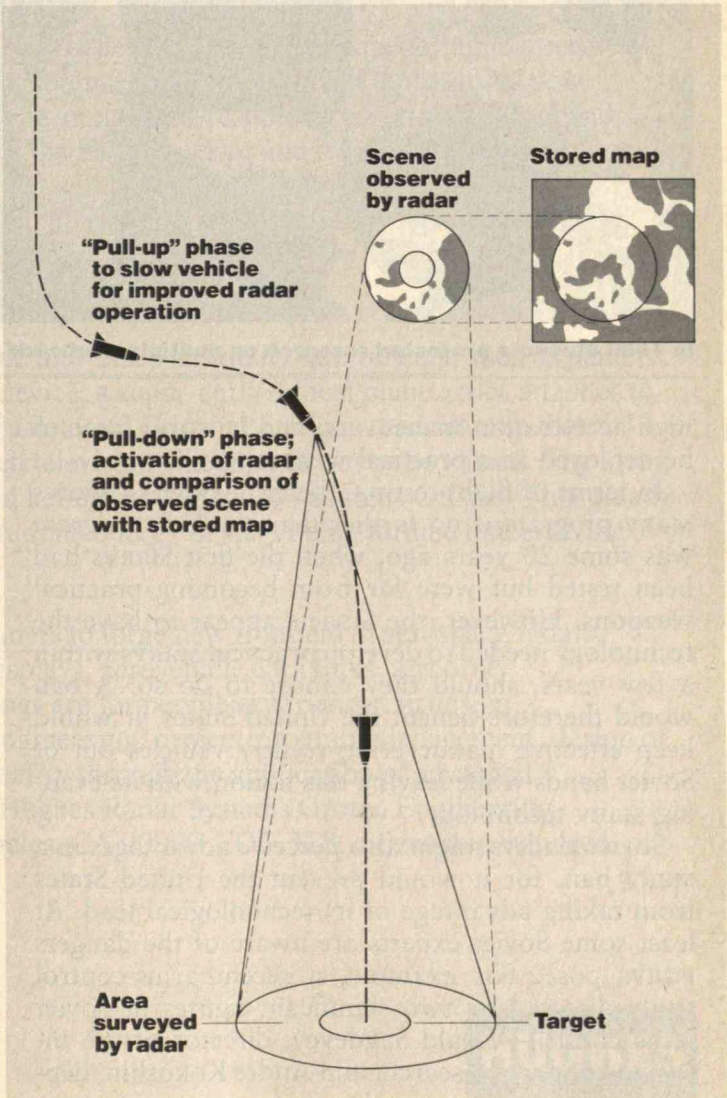


DIAGRAM: TOM BRIGGS DESIGN (ADAPTED FROM FREDERICK LUND, MARTIN MARIETTA CORP.)



In 1969 students protested research on multiple warheads, a technology that has since been widely deployed.

high-acceleration maneuvers, and it is too large to be deployed as a practical weapon.

In terms of flight testing, then, the Soviet Union's MARV program is no further than the U.S. program was some 20 years ago, when the first MARVs had been tested but were far from becoming practical weapons. However, the Soviets appear to have the technology needed to develop practical MARVs within a few years, should they choose to do so. A ban would therefore benefit the United States. It would keep effective manuevering reentry vehicles out of Soviet hands while leaving this nation with its evading-MARV technology.

Soviet leaders might also perceive advantages in a MARV ban, for it would prevent the United States from taking advantage of its technological lead. At least some Soviet experts are aware of the dangers PGRVs pose. For example, a recent arms-control study directed by two significant figures in Soviet arms control—Roald Sagdeyev, director of the Institute of Space Research, and Andre Kokoshin, deputy director of the Institute of USA and Canada Studies—warned that PGRVs "could foster in adventuristic and militaristic minds additional illusions with regard to the feasibility of waging a 'limited' nuclear war."

Attempting to ban the deployment of MARVs without limiting development and testing would be ineffective. Satellites used to verify weapons counts cannot look inside missile silos to examine the reentry vehicles that missiles carry. Even on-site inspectors could be fooled if other warheads were temporarily switched for MARVs.

A ban on further flight testing of MARVs would be a much more promising approach. Without flight testing, complex reentry vehicles cannot be reliably developed. Enforcing the ban would present some problems, though not insurmountable ones. Both superpowers already monitor ballistic missile flights by satellite, ground-based radars, airplanes, and ships, but distinguishing between conventional reentry-vehicle tests and MARV tests would require close-range

PHOTO: MIT MUSEUM

SCIENCE/SCOPE®

A speech-recognition system developed at Hughes Aircraft Company is capable of saving approximately $1.5 million per year in data entry and handling costs alone. After successful prototyping, the system was put on line in radar assembly areas. The voice input system allows inspectors to describe problems in plain language to personal computers, which have vocabularies of up to 1,000 words each. The computers give verbal instructions, repeat the inspector's words for verification, and then record the information. This lets operators keep their eyes and hands on the products they are inspecting. It is estimated that paperwork will be reduced 80 to 90 percent, and human errors caused by manually typing information into the computers will be eliminated.

An immense Intelsat VI satellite, the world's largest commercial communications satellite, successfully met performance requirements when it was tested for the first time as a complete system. Scheduled to be launched from the European Ariane rocket in 1989, the satellite is the first in a fleet of five satellites being produced for INTELSAT, an international cooperative of 114 member countries. Each of the five satellites can carry 120,000 telephone calls and at least three television channels simultaneously. Intelsat VI, designed and built by Hughes, measures 39 feet high with its antennae fully deployed.

Airborne radar systems for the 1990s and beyond will benefit from a new, frequency agile microwave reference unit under development at Hughes. The reference unit will enhance the ability of new airborne radar systems to provide ship imaging, long-range high-resolution ground mapping, and reduced mutual interference. The unit will provide the radar receiver and transmit signal generator with 96 channels across a 1 gigahertz bandwidth and will be able to switch channels in 30 microseconds. Older reference units provide 32 channels and require 5000 microseconds to switch channels. The new reference unit has a volume of 120 cubic inches, nearly 50 percent smaller than older devices.

Astronomers using a new advanced detector device may discover totally new objects, such as planets around other stars and failed or dying stars. The device, a super-chilled focal plane array, attaches to the bottom of an infrared telescope. It consists of a detector chip and a silicon readout chip that converts energy data into video signals from which television-like images can be produced. The array, developed and built by Hughes, is cooled by liquid helium to -223 to -263 degrees Celsius. This greatly increases the detectors' ability to sense the faint radiant energy of stars being formed and evolving within thick gaseous clouds, known as nebulae.

Hughes needs engineers, scientists, and programmers to forge new frontiers in aerospace radars, weapon control systems and avionics, airborne displays, aerovehicle data links, airborne countermeasures, and processors. Current openings are for people experienced in design, development, test and manufacture for systems engineering, project/program management, design of circuits and mechanisms, and bringing these to reality through the application of advanced manufacturing techniques. Send your resume to Hughes Radar Systems Group, Engineering Employment, Dept. S2, P.O. Box 92426, Los Angeles, CA 90009. EOE. U.S. citizenship required.

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Now precision-guided warheads pose a threat, but so far the only one that has been deployed is on the intermediate-range Pershing II. It is slated to be destroyed under the recently signed arms accord.

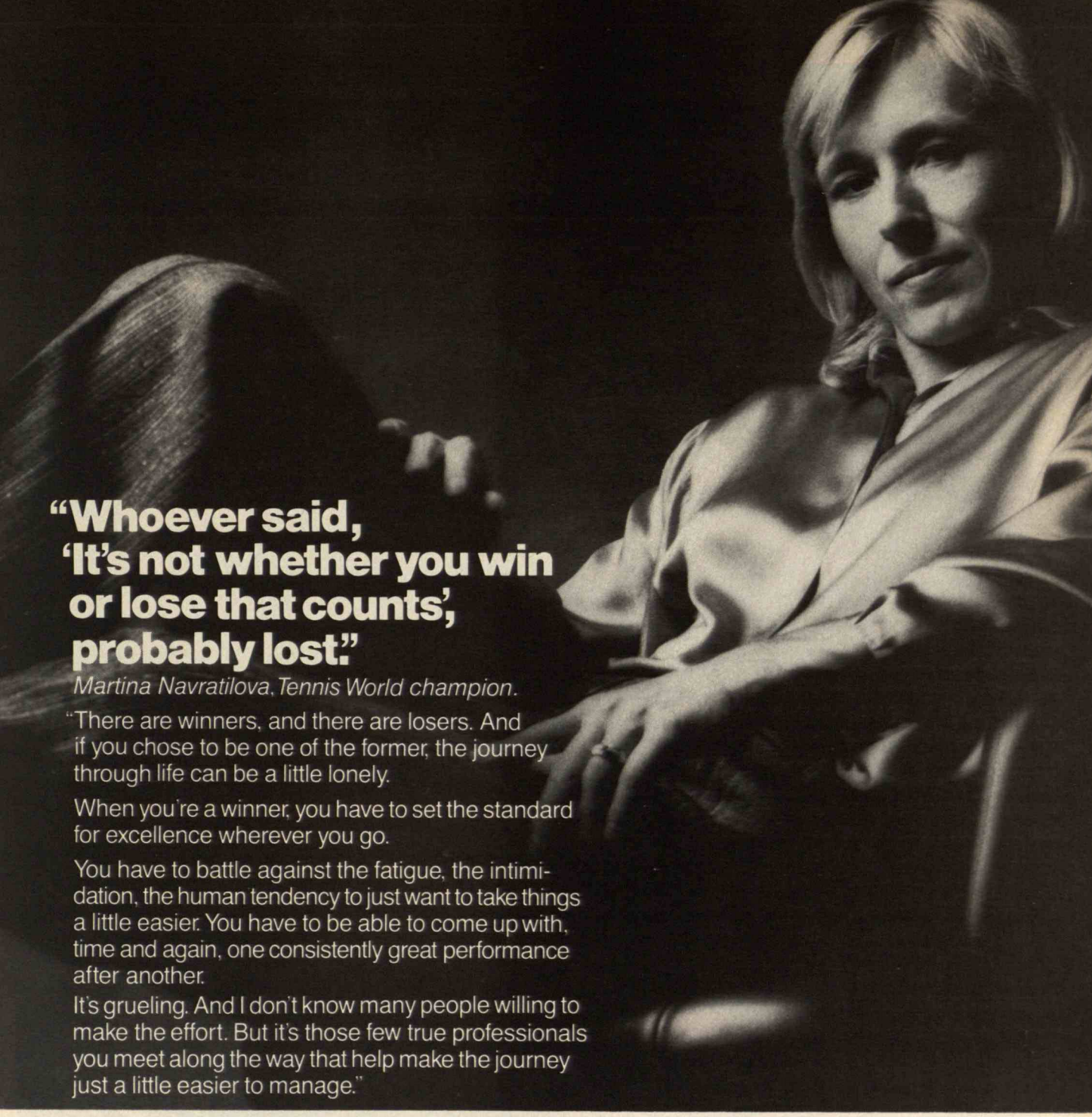
observation. This might mean that each side would have to place small monitoring radars near the other's test ranges. However, there is precedent for such on-site test monitoring. The Natural Resources Defense Council, a U.S. environmental group, is already using seismic stations in the Soviet Union to monitor nuclear testing.

A MARV flight-test ban would have to be total. Banning PGRVs without banning evaders is impossible because the difference is too difficult to verify. Indeed, the two kinds of maneuverable reentry vehicles overlap considerably. Some PGRV designs could also evade, and some evaders have considerable accuracy.

A ban would also have to go into effect by the early-to-mid 1990s. Once the United States has extensively tested PGRVs, the Soviet Union might reasonably suspect that we could deploy them even after a test ban. That would remove the primary bargaining chip we have to convince the Soviets to restrain their MARV testing, much as U.S. testing sealed off the possibility of banning multiple-warhead missiles two decades ago.

Because of MARVs' role as a way to counter missile defense, however, there will be no agreement on these vehicles until the future of the ABM Treaty is settled. Indeed, a MARV test ban should be explicitly linked to the ABM Treaty. If either of the superpowers begins deploying widespread missile defenses, the other side should be free to resume MARV testing to counter them. In the end, a MARV agreement is only likely if set in the context of a grand compromise that trades limits on defenses for reductions in offenses.

The greatest barrier to serious consideration of a MARV ban may, however, lie not in these issues of verification and timing, but in the psychological difficulty of peering into the future. The advantages of evading MARVs are here today, while the dangers of PGRVs lie buried in a distant tomorrow. By the time we realize that the sword we are forging is double-edged, it may be too late. □



"Whoever said, 'It's not whether you win or lose that counts', probably lost."

Martina Navratilova, Tennis World champion.

"There are winners, and there are losers. And if you chose to be one of the former, the journey through life can be a little lonely.

When you're a winner, you have to set the standard for excellence wherever you go.

You have to battle against the fatigue, the intimidation, the human tendency to just want to take things a little easier. You have to be able to come up with, time and again, one consistently great performance after another.

It's grueling. And I don't know many people willing to make the effort. But it's those few true professionals you meet along the way that help make the journey just a little easier to manage."

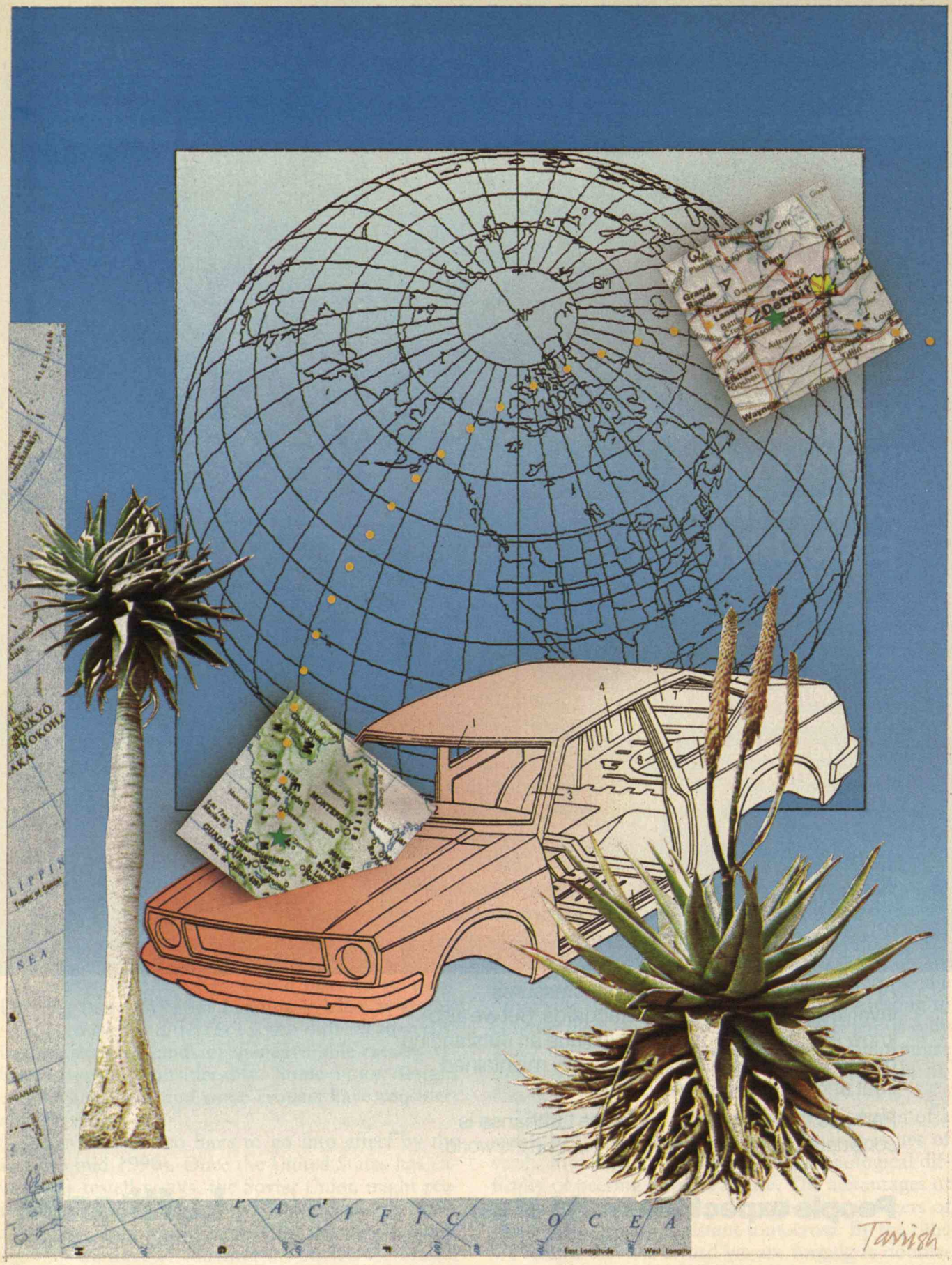
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High-tech production abroad may keep American automakers competitive while undermining the U.S. economy.

High Tech Goes THIRD WORLD

BY HARLEY SHAIKEN

On the the outskirts of the bustling city of Verde (population 500,000) lies a sprawl of glass and concrete, an ultra-modern plant straight out of Silicon Valley. But what gets produced here is car engines, not microchips. And the battered buses coughing diesel fumes into the air, the dense lines of houses tottering down dirt side streets, tell visitors they're in the Third World, not the First.

This is northern Mexico. The engine plant, a unit of what we'll call Universal Motors, is one of a growing number of offshore factories that may foretell a new global future for the American auto industry. The technologies at Universal's Verde plant rank among the world's most sophisticated in the difficult work of engine production, which requires highly skilled labor. Some 90 percent of the Verde plant's output is scheduled for export to the United States. Representing a $250 million investment and a yearly capacity to produce more than 400,000 engines with a slender 1,100-member workforce, the factory is a small gem of global production. In the words of its director, it brings together "U.S. managers, European technology, Japanese manufacturing systems, and Mexican workers."

Hybrids like this are quiet but insistent developments in the strategy of American heavy industry to remain internationally

ILLUSTRATIONS: LAURA TARRISH

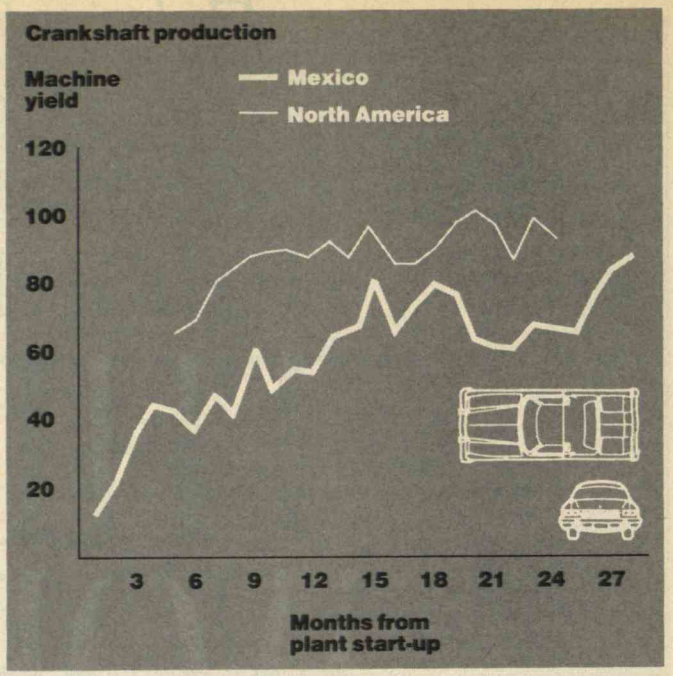
competitive. With an uneasy eye on their rivals, especially Japan, U.S. firms are moving high tech to newly industrializing countries (NICs). Their initial successes are putting to rest an idea that has long been an article of faith among experts: that while labor-intensive, low-tech production may flourish in the Third World's climate of low wages and lesser skills, capital-intensive production requires America's skilled workforce and well-developed industrial infrastructure.

No one has ever looked closely at the workings of multinational high technology in the Third World, so I began a study of Universal's Verde plant in 1983, with M.I.T. graduate student Stephen Herzenberg. (Verde is a fictitious name. In exchange for access to the factory, we agreed not to divulge its real location or the company's identity.) We tracked the plant's operations beginning six months after the first engine came off the line through early 1986. Our purpose was to compare its performance with one of the company's U.S. factories that made the same engine in similar volumes. The latter was an old plant converted to high-tech production at a cost of $150 million.

There were other differences between the two plants. Most of the young Mexican workers (21 years old on average) were seeing a factory for the first time; their U.S. counterparts were seasoned veterans who averaged 16 years of service. Verde is in a largely non-industrial area; the U.S. plant has ready access to the suppliers and tool shops in the industrial Midwest. And Verde managers had almost complete shop-floor flexibility compared with their U.S. counterparts.

Initially it seemed unlikely that the Mexican plant would turn out engines in quantities, at speeds, and with quality comparable to American levels. Yet Verde proved its doubters wrong. Overall it turned out engines of high quality at 80 percent of the U.S. plant's machine efficiency and 75 percent of its labor productivity after little more than two years of operation.

Verde is part of a general trend in the auto industry. By 1988 "captive imports"—cars produced offshore but sold under U.S. nameplates in North America—will account for an astonishing 20 percent of all auto imports, up from 6 percent in 1984. Much of the increase will come from four NICs: South Korea, Taiwan, Mexico, and Brazil. Ford's new plant in the Mexican city of Hermosillo alone—a $500 million high-tech investment—will be able to export 130,000 Mercury Tracers a year. General Motors also plans yearly production of 120,000 Chevrolet Celebrities and similar cars in Mexico for export to the United States beginning in 1989. Exports of Mexican auto parts to the United States have already skyrocketed from $550 million in 1982 to $1.79 billion in 1986.



These experiences are proving that U.S. multinationals, in moving to NICs in their fever to outpace Japan, can indeed be "competitive." Yet in the long run, the costs of such moves may outweigh benefits as the success of individual firms drains the United States of manufacturing jobs, undermining the overall economy.

Opting for Mexico

In the late 1970s, when Universal decided to develop a new four-cylinder engine for a planned compact car, Mexico ranked high on a list of potential production sites. A low-tech Universal plant in Mexico City had already been producing small volumes of engines for the domestic market. The company had established that plant in response to 1960s legislation that obligated multinationals selling cars in Mexico to produce domestically a percentage of every vehicle sold. In 1977 the Mexican government raised the domestic requirement to 65 percent and decreed that multinationals must balance the parts

HARLEY SHAIKEN is associate professor in the Department of Communication at the University of California at San Diego and research associate in its Center for U.S.-Mexican Studies. This article is based on material in Automation and Global Production, *recently published by the center.*

MIT

JANUARY 1988

SPECIAL REPORT:

AN EXUBERANT LAUNCH FOR THE CAMPAIGN FOR THE FUTURE



MIT
JANUARY 1988

THE CAMPAIGN FOR THE FUTURE 5
A star-studded launch for M.I.T.'s largest-ever fund

The Goals in a Nutshell 6

The Case for $550 Million 7

A Gift for the Future of Physics 9

Faculty Report on Research 10

THREE STRIKES OF NOBEL LIGHTNING 14

FIGHTING BLINDNESS WITH ORBIS 16
"The most exciting years of my life,"
by Phil Tietbohl, '84

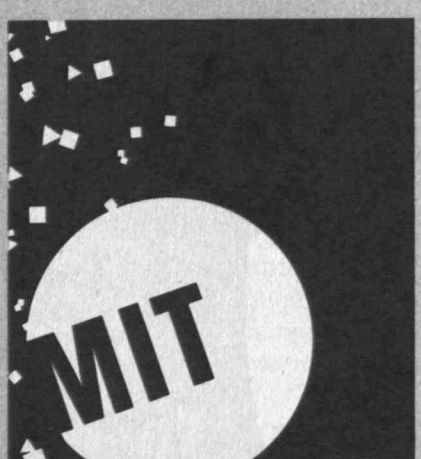
UNDER THE DOMES 19

CLASSES 21

COURSES 37

OBITUARIES 43

PUZZLE CORNER 45



ABOUT THE COVER
Confetti and balloons set a mood of confident celebration as M.I.T. launched the record-breaking $550 million "Campaign for the future" on October 22 and 23.

M.I.T. Families, Giving That Supports Divestiture



WE THOUGHT THEY WERE THE "ONLY"; WE WERE WRONG!
You wrote of Mark Y.D. Wang, '87 (*August/September, p. MIT 11*), that his family is "well on the way to being the only nuclear family to all hold M.I.T. degrees." Well, there is at least one such family already. My father was Stanley T. Wray, Jr., '56, my mother Marie M. (Max) Wray, '59. My brother is Stanley T. Wray III, '82. And since I married an alumnus—Walter van Roggen, '78—maybe our daughter will carry on the legacy . . .

CHRISTINE M. (WRAY) VAN ROGGEN, '83
Stow, Mass.

(Last month's "Courses" department (November/December *page MIT 36*) reported on another M.I.T. family: two children of Donald M. Black, Ph.D.'47, and Elizabeth Sackman Black, S.M.'47, have attended the Institute: Donald T. Black, '71, and Thomas P. Black, '80.—*Ed.*)

DIVEST TO OPPOSE APARTHEID
The checks sent early this year to fulfill my pledge to the scholarship program of the Association of M.I.T. Alumnae (AMITA) will be my last donation until such time as M.I.T.'s portfolio is divested of all stocks of companies doing business in South Africa. Until then, I will send my annual contributions to the M.I.T. Endowment for Divestiture.

I did not make this decision lightly. I knew when I began contributing that M.I.T. invested in companies doing business in South Africa but felt that it was important for me to help M.I.T. provide needy students with scholarships. Now, however, the situation in South Africa has deteriorated to the point where I can no longer justify giving monetary support to an institution that refuses to accede to the wishes of the vast majority of black South Africans, who strongly support disinvestment as an effective way of ending the scourge of apartheid.

I have followed the debates over divestment in the world at large and in the pages of *The Tech* (of which I once served as editor-in-chief). I simply am not convinced by President Paul Gray's rationales for M.I.T.'s continued refusal to divest. The claim that divestiture is symbolic rather than an effective means of influencing events in South Africa is belied by the growing number of companies leaving South Africa. I do not accept President Gray's argument that divestment is inappropriate for M.I.T. as an educational institution because it is a political act. Because of its role and prestige, many of M.I.T.'s actions are political, some (spinning off Draper Laboratory, refusing to allow classified research on campus) overtly so. Most importantly, the *refusal* to divest is just as much a political statement as divestiture—and a political statement with which I strongly disagree.

The loss of my contributions, however small, cannot be rationalized by counting me among those digruntled alumni/ae who would in any event fail to support their alma mater. I was and am a strong supporter of M.I.T.—I was active in campus activities as a student and am currently participating in AMITA's high school visiting program. And to demonstrate that I would have given M.I.T. money but for its refusal to divest, I will be making regular contributions to the Endowment for Divestiture. In fact, I gave the endowment $50 to offset the $50 I enclose today, which I am donating only because I pledged to do so before hearing about the endowment. I hope that I will not have to make many more contributions to the M.I.T. Endowment for Divestiture because M.I.T. will act promptly to join the many educational institutions, cities, and states that have expressed their opposition to apartheid by divesting.

STEPHANIE POLLACK '82
Cambridge, Mass.

BY LAURA B. CLAUSEN, MCP '67

Success:
Planning Had Nothing to Do with It

I was asked to speak on the conference theme, "How Do You Spell Success?" It really incorporates two questions: How do you define success, and how do you achieve it? It's the first question that I find a lot more interesting, especially when addressed from the perspective of women in the workplace.

You probably could have guessed that I didn't decide one morning when I was six years old that I wanted to be a higher education administrator. I think there are people who approach their careers very much from a top-down perspective. They know what they want to do, where they want to go, and they map their route to get there. My career developed from the bottom up.

After I graduated from Mount Holyoke in 1961, I worked for Louis Harris Associates in the early years of opinion polling and at the National Bureau of Economic Research, before enrolling at M.I.T.

I was intrigued by the concept of urban planning—using government resources to implement social change. As an added plus, M.I.T. did not require the graduate record exams at that time.

I had a marvelous two years. My class had few women but a broad range of students from all over the world. (I remember one who had already built a city for 250,000 people; he was at M.I.T. learning how to do it.)

Education really counts. It was my ticket, and it's been the basis of my credibility in whatever I have gone on to do. After I received my M.I.T. degree, I had many more options.

So I decided to be part of the launching of the Massachusetts Bureau of Relocation. The bureau helped individuals



and businesses that were displaced through public projects such as turnpike construction or urban renewal. Back in the 1960s, dislocation of people through eminent domain was a major public policy issue, and the bureau protected the rights of those displaced. Like many other jobs in the public sector, the bureau offered substantial responsibilities, even for someone as young as I.

After years I decided I was still too far removed from "the real world,"—I'm still looking for the real world, by the way—so I went to work for the Boston Model Cities Program, at a time when the Johnson administration was pouring enormous amounts of money into urban centers.

I became the director of the Boston Model Cities Facilities Division, which meant I worked with community groups to rehabilitate buildings for everything from health centers to halfway houses for drug addicts. It was a great job; I had to learn about health care, daycare, starting a community college, and more—all new to me.

Then I took six years out of the paid workforce when I had my son; in those days it was not an unusual thing to do. One day I was changing my son's diaper when I got a call from the young man I had hired to replace me at Model Cities. He was by then working in the first [Governor Michael] Dukakis administration, and he was recruiting people to serve on various boards. How would I like to serve on the Board of Higher Education? That was the beginning of my involvement in higher education in this state.

From that volunteer position, I moved on to part-time consulting for Arthur D. Little in Cambridge—working on projects such as assessing the recruitment patterns for Spellman College. The person for whom I worked turned out to be the next governor's choice for secretary of higher education, and he asked me to come with him into that secretariat. That was the first of a series of posts that led to my becoming chancellor of the Massachusetts Board of Higher Education, the precursor of the present Board of Regents of Higher Education.

Looking back on my career, I can tell you that planning had nothing do with it, but responding to opportunity did.

As an adolescent sailor, I learned that the thing I most feared—capsizing the boat—was actually a manageable situation. It was a good lesson for life.

Well, professionally, what's the worst thing one can imagine? For me, it was that I was the first woman chancellor of education in the country, I, I had a job that I loved, I had a really fine staff of 40 people working for me, and suddenly the whole agency we were part of disappeared.

There had been plenty of warning of an impending reorganization in public higher education; and I had been sitting on the commission discussing the reorganization for a good two years. But what caught most of us off guard was the fact that the reorganization was carried out by the Legislature's Ways and Means Committee chairman, via the state budget, not the Commission on Higher Education, as we had expected.

And so it came to pass that in 1981, the Massachusetts Board of Higher Education was replaced by the Board of Regents of Higher Education. Reorgan-

Laura Clausen is associate vice chancellor for policy and planning for the Massachusetts Board of Regents of Higher Education, an autonomous state agency with a budget of $650 million. She was the keynote speaker for the 1987 AMITA and SWE conference on "Women in Technical Careers." In this edited version of her address, she shares some of the insights gained as a high-level administrator in the public sector.

PHOTOS: STU ROSNER

"Every woman ought to take Gambling 101. Betting on yourself is very important.

ization is a fact of life in the public sector, but this was particularly cataclysmic: six different agencies were eliminated and one created.

I had to make a decision. I was offered an exciting job in another state, and I didn't know what would be available for me with the new Board of Regents. But I made the choice to stay through the transition, help set up the new board, and try to have the valuable people who worked for me transferred to that new organization.

One of the reasons I made that decision, quite frankly, was that I had a son in school, and I didn't feel very mobile. But it took me about three years to reconcile myself to the fact that circumstances outside my work had influenced such an important professional decision. I have no doubts now, however, that it was the right move.

This leads me to a prime element in my definition of success: to be able to look back and see that I have made most of the right kind of decisions. Success is also being able to look ahead and see that I still have someplace to go.

There are other considerations in defining success:

I can't go all out for something if it is not meaningful to me, if it does not have a clear connection to social purpose. Education, for example—I really believe in the stuff.

Money is not irrelevant, but it is not the driving force in my career. I only need enough of it to do the things I enjoy and to help my family when needed.

It is also very important that my colleagues respect my integrity, that I can trust the people who work for me and vice versa.

If I were to try to list the qualities that have been the most valuable to me in realizing that kind of success, I would have to include a willingness to take risks. I didn't worry much about the potential risks in my career until I got a divorce; then I knew that a lot depended on whether I brought home the bread. And it wasn't just economic anxiety; I was coping with a feeling of failure in my personal life. It was very important to me not to fail in my professional life.

I put too much stress on myself; I was trying to plan everything out, ten steps down the road. In life, you can't do that. After a while, I began to realize that I was doing just fine. I became more willing to trust my instincts in professional decisions. In one sense, every woman ought to take Gambling 101. Betting on yourself is very, very important.

I try not to react out of anger; I'm just not effective when I'm angry. A sense of humor, on the other hand, is indispensable (whether raising a teenager or on the job). Never underestimate its value in helping you put across a message. And if humor is not likely to sell an idea to the decision-makers, try having someone else deliver your message.

Candor and directness are also effective. I recall that during the breakup of the Board of Higher Education, I was determined that the reorganization had to really mean something if we were going to do it, and I gave some very frank testimony to that effect. When I finished, one member of the legislative committee leaned over and said, "Thank you very much, Chancellor Clausen. I just want to say that you're a gutsy broad." I felt that was one of the nicest compliments I had ever received.

Most satisfying for me are situations where success requires real innovation. I look for the other people who would welcome change. By building on that core of people, I have been able to change expectations and outcomes. For example, I once had the assignment of forecasting future enrollments for public sector colleges. It sounds easy, but it's not. In the first place, it's always hard to predict how many high school graduates will opt for a public versus a private institution. And in the second place, I found that Massachusetts had no useable local area population forecasts by sex, race, and age.

It was much too big a job for my budget, so I started making the rounds of other agencies. I found an ally, the Massachusetts Institute of Social and Economic Research at the University of Massachusetts, Amherst, which had expertise in generating the data. Together we tracked down the administrators in positions like mine, the people whose work depend on solid numbers, who would also be concerned about the lack of reliable demographic data. I enlisted agencies as diverse as the Departments of Education and Public Health, and the Executive Office of Transportation.

We went to the head of the state's Executive Office of Administration and Finance and sold him on the idea. "This is great, this is really wonderful," he told us. "Now you guys put up the dough!" We managed to get an initial commitment from the Department of Capital Planning and Operations and a second from the Department of Public Works. With that leverage, we were able to pry more financing from several other sources. By working with a handful of people in many agencies, we launched a program of gathering demographic data that is now updated biannually with support from the executive branch, the Legislature, and a statewide advisory committee.

But sometimes it's all right to let someone else fight the battle. More than a year ago Massachusetts went through the selection of a new chancellor for the Board of Regents of Higher Education. Some of you may have read about it. It was a very sensitive political issue. I was the staff person asked to be on the search committee—the only one on the committee whose job was potentially at stake. It was a very stressful situation. Another time, I might decline to be the standard bearer. Keep in mind, however, that if it comes down to professional combat, you've got as much right to survive as anyone else.

Evaluating my own success is always a question of gains and trade-offs. I work within the decision making-process and the priorities of my organization; I'm not a free agent. But I do have the freedom to express myself and present the issues the way I see them. Sure, I am playing ball in "the system," but I'm swinging my racquet the way I swing. And I occasionally get the great feeling of hitting the sweet spot. □

CAMPAIGN
The Kick-off

In fundraising parlance, the Campaign for the future *has been "kicked off," its launch officially announced by Chairman of the Corporation David S. Saxon, '41, on October 22. "This is an endowment campaign," Saxon said at the black-tie dinner at Walker Memorial, "not a bricks-and-mortar campaign."*



The $550-million effort has been given "a spectacular start," he reported, by donations of more than $200 million to the Nucleus Fund.

Over the next five years, some 4,000 volunteers backed up by Institute staff will approach foundations, corporations, and individuals—notably, 70,000 alumni. They will make the case that support for M.I.T. is essential to foster regional, national, and world well-being, to spur scientific and technological advancement, and to assure that many of the world's ablest students, teachers, and researchers will continue to do their best work in this supportive and exciting environment.

The kick-off was a decidedly exuberant affair, taking up the better part of three days and overlapping with the 1987 National Alumni Conference (NAC—about which more in the February/March Technology Review*). Although the Campaign was announced only days after "black Monday" on the stock market, Treasurer and Vice-President for Resource Development Glenn P. Strehle, '58, was undaunted. He reminded everyone that, though the Leadership Campaign was also announced at a low point in the market in 1975, this fund drive exceeded its goals, as has every other similar effort at M.I.T. since World War II.*



Announcement on October 21 of the 1987 Nobel Prize in Economics to Institute Professor Robert S. Solow, coming right on the heels of the Nobel Prize in Physiology or Medicine to Biology Professor Susumu Tonegawa, couldn't have been better timed to illustrate the relevance of M.I.T.'s campaign goals to the needs of humankind.



It would be hard to overestimate the impact of the Nobel Prizes on the level of campaign enthusiasm.

The kick-off began with a ceremony lauding Cecil H. Green, '23, honorary chairman for the campaign, for his $6 million grant for development of the Green Center for Physics. The schedule continued through days of hard-hitting meetings on fundraising issues and evenings of dining and dancing, punctuated by introductions of campaign leadership and goals.

There was a substantial series of talks by faculty members whose work exemplifies both the intellectual promise of M.I.T. and the impact of donor dollars. Events wound up with an M.I.T. Symphony concert featuring cellist Carlos Prieto, '57.

There were many speeches, built around key themes. The leaders of the faculty, administration, and alumni explained why they are convinced that M.I.T. needs a major infusion of new resources and how they personally had been persuaded to allocate stunning proportions of the next five years of their lives to this effort.



Committed donors and campaign volunteers joined Resource Development and Alumni Association staff, members of the Corporation, administration, faculty, and students at the various events. The NAC drew alumni activists such as educational counselors, club officers, and alumni fund solicitors to sessions on their own volunteer specialties as well as to campaign-related events.

They watched a campaign video designed to convey the reality of M.I.T. in the 1980s. They marveled that, as venues for kick-off dining and dancing, Walker Memorial and Dupont Gym could be so elegant. The reveled in art and technology in the Wiesner Building. And they button-holed President Paul E. Gray,'54; Provost John Deutch,'61; professors like Philip S. Khoury, associate dean of the School of Humanities and Social Science; or student leaders like Manuel Rodriquez, '89, president of the Undergraduate Association, to ask questions or make points.



More than anything, those who came to the kick-off cemented the relationships with each other and with M.I.T.—based on respect, shared commitment, and no small measure of humor and camaraderie—that will make the campaign a personally as well as institutionally rewarding experience. □

***Dinner at Walker Memorial; an address by Chemistry Professor Mark Wrighton; a Media Lab demonstration with Stephen Benton, Bill Kelly, and Steve Ocko; lively dancing; a concert by Carolos Prieto, '57—all part of the kick-off of* Campaign for the future.**

PHOTOGRAPHS: DONNA COVENEY/L. BARRY HETHERINGTON

CAMPAIGN

The Priorities

ENDOWMENT FOR FACULTY CHAIRS $100 MILLION

Endowed chairs are named professorships supported by the income on endowment assigned to them, with discretionary funding in addition to salary often provided. They are highly prized by faculty members because they represent recognition within the scholarly community and assure independence to pursue innovative educational or research ideas that might not find financial support elsewhere.

From an institutional viewpoint, endowed chairs represent a means of attracting and retaining the most able and distinguished scholars and teachers. Currently, only 174 endowed chairs are funded at M.I.T., which has a distinguished faculty of around 1,000. To enable M.I.T. to give more of its distinguished scholars the recognition they deserve, the campaign is seeking $100 million for endowed professorships.

ACADEMIC PROGRAMS $225 MILLION

The campaign seeks $100 million in expendable funds and $30 million in endowment for school-based initiatives that respond to social needs and concerns.

Such initiatives in the past have placed M.I.T. at the leading edge of investigations in areas such as polymers, cancer research, and biotechnology. New initiatives for which support is required will explore such issues as manufacturing and productivity, hazardous substance management, international security and arms control, and the new science of interfaces—the study of chemical and physical phenomena where two dissimilar materials meet.

In keeping with M.I.T.'s tradition of promoting interdisciplinary research and teaching, $15 million in endowment is being sought for Whitaker College, which has made substantial contributions in brain sciences and other interdisciplinary enterprises. Among the latter is the Harvard-M.I.T. Division of Health Sciences and Technology, which combines technology and biomedical science.

Another $70 million in endowment is earmarked for the support of faculty research—basic research; research in disciplines where federal and corporate dollars are in short supply such as architecture, economics, mathematics, and linguistics; and research by young professors who are just launching their careers. Such discretionary funds will empower M.I.T. to exploit research opportunities without depending on outside sponsorship. And since research is a major tool for education here, these funds will also assure that educational programs are independent of research support.

Also sought is $10 million in endowment to support the library system and The MIT Press and to strengthen the place of the arts in the educational experience of M.I.T. students.

STUDENT SUPPORT $120 MILLION

Meeting the campaign goal of $50 million for undergraduate financial aid is integral to maintaining M.I.T.'s "need-blind" admissions policy that permits the Institute to enroll the ablest applicants, regardless of their ability to pay. Also sought is $60 million for graduate student financial assistance. Together, these funds will assure that M.I.T. will remain able to attract and support the most talented young men and women who are qualified to study here.

Further, the campaign seeks $10 million in endowment to support the Undergraduate Research Opportunities Program (UROP) and to fund new initiatives aimed at improving M.I.T.'s undergraduate program.

NEW AND RENOVATED FACILITIES $65 MILLION

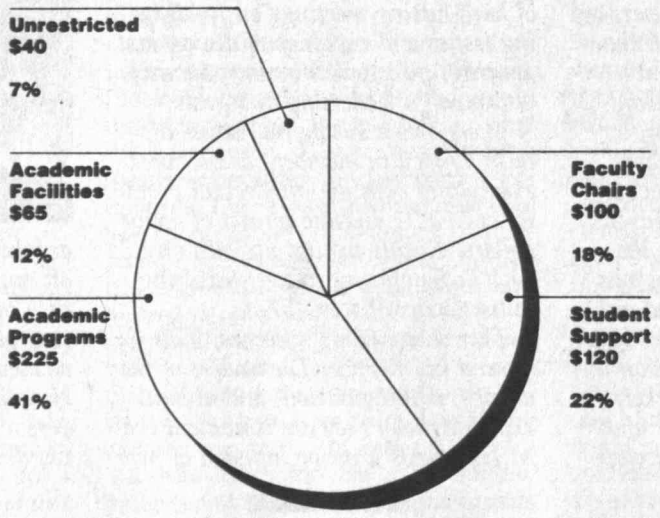
Several facilities needs have been identified. Two of the most pressing are the creation of a new science complex and the construction of housing to accommodate 700 graduate students.

Central to the science complex proposal is a new 85,000-square-foot building for the Department of Biology. Its construction would free space to be renovated for the Departments of Physics and of Applied Biological Sciences. This would have the important advantage of bringing together the physics faculty, now scattered widely over the campus for lack of adequate central facilities.

The new student housing is proposed to reduce the dependence of graduate students on the Boston real estate market. Currently, M.I.T. is able to offer housing to only about 26 percent of its graduate students.

GIFTS FREE OF RESTRICTION $40 MILLION

Increasing unrestricted endowment is a particularly high-priority goal, since it would provide financial flexibility. Such flexibility is necessary if M.I.T. is to create new programs and make curricular revisions in response to new technical opportunities and social, political, and economic priorities. Of the $40 million goal for gifts free of restriction, $25 million will be sought for general endowment. □

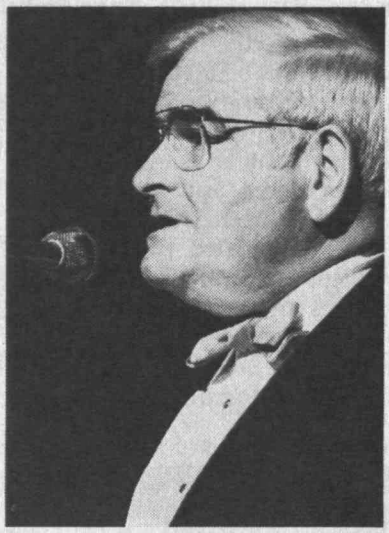


CAMPAIGN FOR THE FUTURE: $550 MILLION

CHART: TOM BRIGGS DESIGN

CAMPAIGN

The Case



PAUL GRAY:

Liberating the Faculty To Reflect

President Paul E. Gray, '54, spoke on several occasions, on topics as broad as the agenda of the Institute itself. M.I.T. announced its campaign, Gray said, mindful that "over the past quarter century, there have been growing concerns over the present and future place of science and technology." Technological advances are no longer regarded with universal optimism. Confronting that concern will require "cooperation among people of various disciplines, institutions, and points of view," Gray said, and "and reconciliation of technical considerations with considerations of economics and political, social, and environmental impact."

Gray likened the present ferment in undergraduate education at M.I.T. to the recasting of the curriculum in electrical engineering that took place in the mid-1950s and prepared M.I.T. graduates to work with microprocessors and electronic materials. He reminded his kick-off audiences that the overriding priority at M.I.T. has always been to anticipate the next technological advances, to have the vision to see what directions scientific discoveries are likely to take.

An important campaign goal is to free faculty from the pressures of finding financial support, so that they have more time to reflect on the future and develop curricula that will prepare graduates to be fully involved in that future. Said Gray, "What [M.I.T.] does now will determine the course of science-based liberal education worldwide for years to come."

In discussing the campaign priorities, Gray started with financial aid—a $120 million item, almost entirely endowment. The fact that the self-help that M.I.T. requires of its students (the combination of loans and term-time jobs) is about 20 percent higher than at Harvard, Yale, and Princeton threatens M.I.T.'s ability to attract outstanding students. In turn, that fact threatens the very character of the Institute. "Everyone recognizes that good students come here because of the quality of the faculty," Gray said. "Fewer people realize that good faculty members come here because of the quality of the students."

"This campaign is, and must be, an all-out effort," Gray said. "It calls for excellence in ideas, for the ultimate in energy, for thoroughness in execution. . . . We approach it with the certainty that M.I.T. people have, as Van Bush put it years ago, the habit of success and the confidence born of constant renewal."

There were many opportunities over the kick-off period for members of the M.I.T. community to speak about the need for the campaign and their own personal commitment to its goals. It would be impossible to recreate in these pages the feeling of being on campus—of being bathed in fierce loyalty to M.I.T. and in the most thoughtful dedication to a common purpose. All we can do is give some highlights from some of the remarks.



JOHN DEUTCH:

Endowment Will Enable M.I.T. To Set Its Agenda

M.I.T. has in the past focused on the work at hand, Provost John M. Deutch, '61, wrote in a major campaign statement. "Although we have built an extraordinary record of accomplishment, we have done

so at the expense of building our endowment. Despite the urgency of the problems that call for immediate attention, we can no longer afford to concentrate our efforts on such short-term support.

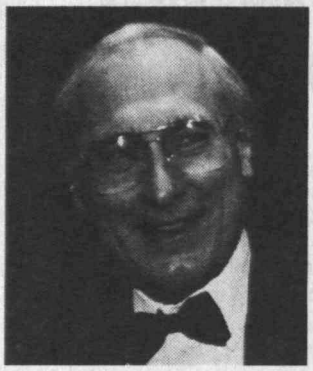
"As the federal government and other outside sponsors narrow their research agendas—and, accordingly, the resources they provide—our dependency on them threatens to limit the range and the character of the scholarly inquiry we are able to undertake. . . . [New] funds will enable M.I.T. to continue to be M.I.T., to continue to be in charge of its lifework."

Deutch said that some 30 research initiatives for which "seed" funding was important had been identified during the campaign planning process, and he discussed three of them. A Commission on Industrial Productivity has been meeting for a year, he said, exploring the factors responsible for the nation's disappointing productivity record. It investigated eight industries in detail, to see how technological change could maximize productivity. The final report of the commission is expected next year, Deutch said, and is expected to have fundamental and wide-ranging educational implications for the Institute.

Second is a planned program in "interface science" that will assemble investigators from chemistry, chemical engineering, and materials science to explore opportunities for collaboration. For example, new instrumentation permits the study of the properties of thin films at the atomic and molecular level.

Deutch's third example involved work at the M.I.T. Center for Cancer Research, where there is more than ample reason to expect further contributions to understanding the processes of cell regulation, the identification of carcinogens, and the development of new, more effective therapies for treatment.

These and the more than 25 other research initiatives are opportunities for intellectual venture capital, Deutch said. They are areas that involve high risks, but also promise great long-term social benefits.



RAY STATA:

The Formula for Economic Success

Raymond S. Stata, '57, president of the M.I.T. Alumni Association and chairman and president of Analog Devices, referred to his company and the New England high-tech community to build a case for the campaign.

"Like so many startup companies in Kendall Square today, my partner, also an M.I.T. graduate, and I started our company, Analog Devices, literally within blocks of M.I.T.," said Stata. "Twenty years later, we employ 5,000 people and are the leaders in our niche of the semiconductor industry.

"Our business success was built on technology leadership. Analog would not be the company it is today without our ability to attract many M.I.T. graduates and to tap their state-of-the-art knowledge.

"From an industrial perspective, M.I.T. has been uniquely successful in melding the aims of higher education with the goals of economic and industrial development.

"The evidence of this is abundantly clear. For example, a study of 216 high-tech companies formed in the Boston area showed that 70 percent were founded by M.I.T. graduates or faculty members—including the most famous, the Digital Equipment Corp., founded in 1957 by Ken Olsen.

M.I.T.'s influence is [also] evident outside of Massachusetts in the founders of such high-tech firms as Hewlett-Packard, Intel, and Genentech, among countless others.

"The formula for economic success in knowledge-intensive industries is well established," Stata said. "Namely, through world-class research, create new knowledge and technology that is relevant to real world problems and needs. And then educate the best and brightest entrepreneurs and professional technologists to transfer these new discoveries into commercial applications. No institution at any place or at any time has been more successful in applying this formula than M.I.T."



GLENN STREHLE:

Our Donors Will Give, Not Sell

"The main purpose of the campaign is to build M.I.T.'s capital base: a total of $350 million out of the $550 million goal is designated for assuring our future," Treasurer and vice-president for resource development Glenn P. Strehle, '58, said at the *Campaign for the future* news conference on October 22.

"Our endowment, which as of today is worth about $1.05 billion, may look large in absolute terms. By the measures that we use, we rank approximately sixth among the large private universities in the size of our endowment.

"However, because of the size of M.I.T.'s operations and our rapid growth, we rank 19th among the nation's private colleges and universities in terms of our endowment per student, and 32nd in our endowment per faculty member.

"The cost of educating M.I.T.'s nearly 10,000 students is about $200 million a year. Tuition covers just over half that, which is about the historic average.

"The difference between collected tuition and cost is made up primarily from gifts from private sources and by income from investments. Right now, investment income covers about 25 percent of our educational costs.

"A significant problem for us has been the declining level of federal assistance for students. The overall reduction in federal student aid since 1980 has been 14 percent, in constant-dollar terms.

"The M.I.T. Corporation has concluded that we have to increase our endowment substantially if we're to remain an institution where outstanding students and faculty have the environment and resources needed to make the most of their talents."

"I want to put the announcement of the campaign in a little perspective," Strehle told reporters, "particularly related to current events in the investment markets."

He noted that even with the October 19 decline of 500 points in the stock averages, the market was still about 15 percent higher than the 1700 level of March, 1986, when he began organizing the campaign.

He said the value of M.I.T.'s endowment had dropped less than $100 million between October 19 and 22, a decline of about eight percent from its level of $1.15 billion on October 16.

In a lighter vein, Strehle quipped that "many of our donors wish that they had made their gifts a few weeks ago, when stock prices were somewhat higher. I am sure that as the market recovers we won't make that mistake again! And that our donors, as they have in the past, will not sell. They will give.



A Geographical Intersection for the Many Pathways of Physics

It's not easy to know how to address Cecil H. Green, '23, one of the most generous benefactors in M.I.T.'s history. At a campaign kick-off ceremony, Green gave the following guidelines: When you're east of Suez, it's Cehcil; everywhere else, it's Ceecil.

His remarks were included in a typically relaxed and unassuming speech at the unveiling of what will be the portals of the Green Center for Physics. The ceremony was the initial event in three days of campaign kick-off and National Alumni Conference.

With a $6 million gift from Green, the new center will be created in the Dorrance and Whitaker Buildings (Buildings 16 and 56) when the Department of Biology moves to a new building to be constructed on the corner of Ames and Main Streets.

Green and his late wife, Ida, "have had the uncommon knack of supporting specific endeavors at just those moments when those enterprises were ready to 'take off'," and the Green Center for Physics is right in that tradition, President Paul E. Gray, '54, said.

"For decades, physics has been dividing into ever finer subdisciplines," Gray said, "and the time for a coalescence has come. The Green Center for Physics will be the geographical intersection where the many pathways of physics will come into contact with each other.

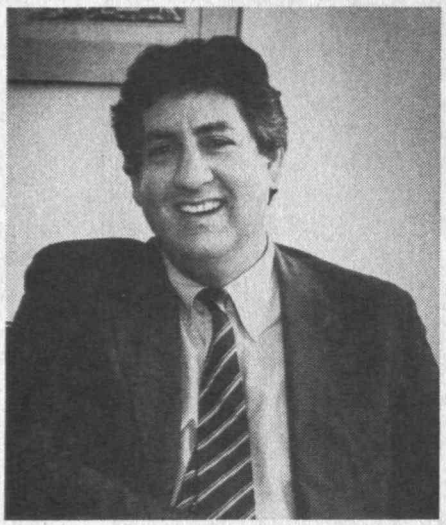
"I believe that when this century closes, we will look back at this moment and realize that physics was poised to profit greatly from more interaction among the subfields and that provision of a physical location that encourages such interaction was an important, determinative act," Gray said.

And of the Greens, he remarked that "they are monumental proof that individuals can make a lasting difference as builders of scientific institutions in the twentieth century." □

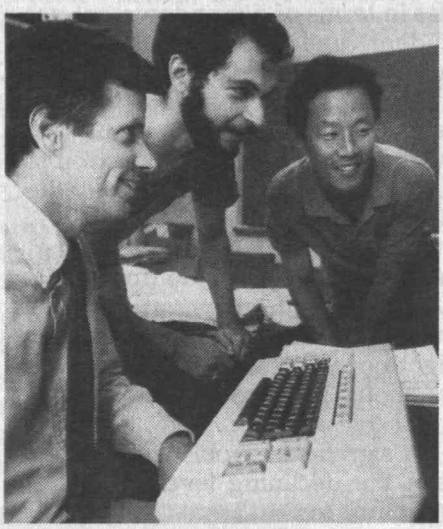
Above: Cecil Green, '23 (center standing), was saluted by (l. to r.) David Saxon, '41, James R. Killian, '26, and John Deutch, '61, at the ceremony announcing the Green Center for Physics.

CAMPAIGN

The Faculty



It's almost a cliche that the greatness of M.I.T. is the greatness of its faculty. And for the best of these are reserved the named professorships, too few in number, that carry special privileges of both rank and funding. In lectures on October 23 under the general theme of "What In the World Is Going On?" nine of these outstanding teachers, described their work.



PHILIP S. KHOURY:

Reconstruction In The War-Torn Middle East

The research of Philip S. Khoury, associate dean of humanities and social sciences, examines war and society in the 20th century. He is focusing on war in the Middle East as a catalyst for change, paying particular attention to the civil war in Lebanon, 1975 to the present.

Why study war in the Middle East? "I believe no other region of the world has the potential for producing the kind of conflagration that can escalate into a military conflict between the superpowers," says Khoury.

In Lebanon, war has brought a myriad of changes. In addition to the hundreds of thousands of Lebanese killed, injured, and maimed, and the physical destruction estimated to be several billion dollars, a whole generation of children has grown up in war and has done a considerable amount of the fighting, Khoury points out. His studies show that the war has hardened sectarianism and has affected all economic areas—agriculture, industry, tourism. Inflation is running about 225 percent per year.

One of the most devastating long-term consequences of this war, claims Khoury, has been the exodus of the middle classes, the backbone of Middle East society. And the alternative to unemployment, especially for the young and unskilled, has been to take up arms. "What better way to perpetuate war than this?" Khoury asks.

So what about Lebanon's future? Has it managed to preserve enough of its old self to form the basis for reconstruction? One essential feature that Lebanon has been able to preserve against the odds, reports Khoury, is a large portion of the population that still supports general intellectual freedom. It is the only country in the Arab world with a free press and is one of the great publishing areas of the region. It is a center of intellectual debate and artistic enterprise. Lebanon still manages to hold free elections and has a parliament amidst an Arab world that has known primarily authoritarian regimes for the last 40 years.

Khoury would like to see the development of an international research project at M.I.T. on the problems of reconstruction, an area of study in which Lebanon would figure prominently. He envisions this project involving M.I.T. specialists, possibly in collaboration with scholars from Europe and the Middle East.

This research would entail looking at other war-torn societies that have managed to rebuild and restore successfully—Germany, Japan, Korea—as well as those who've failed, for example, Northern Ireland. He hopes to develop a broadly comparative and interdisciplinary academic seminar on war, society, and reconstruction that would start with but not be limited to Lebanon.

—*Sandra Knight* □

THOMAS W. MALONE:

Taming The Information Glut

Can the communications revolution that has brought vast amounts of electronic mail to managers' desks help them deal with the cacophony that many call "information overload"?

It can, and it must, says Thomas W. Malone, Douglas Drane Career Development Associate Professor in the Sloan School of Management.

Malone's confidence is based on a concept he calls the "information lens"—a system developed at M.I.T. that relies on its user's instructions and its own artificial intelligence to sort and prioritize electronic information.

It works this way, Malone told the symposium audience: the user can establish any number of categories into which the information lens is to sort incoming messages. For example, communications from marketing or manufacturing concerning a new product can be given top priority. Meeting notices can be sorted by date, subject of meeting, or both. And messages from a certain sender can be printed and filed.

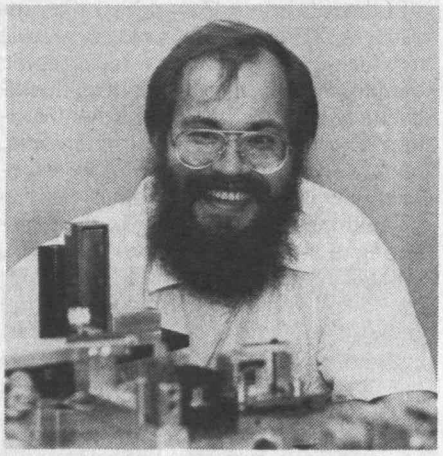
To help the system process messages, senders can use a variety of standard formats, or templates. The notice of a meeting can be marked as such and the proposed purpose, date, location, and

PHOTOS: DONNA COVENEY

time put in spaces provided. In other cases the subject of the message can be shown, and always the message must indicate the names of the sender and the addressees.

Does the information lens "understand" its user's mail? In a very limited way, said Malone: it uses certain information about a message to draw inferences about the mail's importance and distribution. It is an "intelligent hybrid," he said—helping do routine processing while leaving the rest to people.

Malone believes that the information lens can make a dramatic difference in how organizations communicate. More people can be better informed, and there can be better, more decentralized, and faster decisionmaking. Organizations may become less heirarchical, more responsive to their environments. □



ALEXANDER SLOCUM:

Precision Can Be Large or Small

He started out searching for ways to use robots in the construction industry. But with the help of a George Macomber Career Development Professorship, Alexander Slocum of the Department of Civil Engineering has developed a new approach to designing ultra-precision mini-machines.

The first product of Slocum and his students was "Wallbot." It could erect the studs for straight walls, leaving openings for future doorframes, at the rate of two to five feet per minute. At $240,000 it was a good investment for large contractors with substantial office-building commitments: Wallbot's cost could be recovered by its savings in building 240,000 feet of interior wall—normally about 28 months of work.

Next came Blockbot, a robot to build straight walls of concrete blocks up to 30 feet high. It can lay 10 to 20 blocks a minute, and an owner can recoup its $500,000 cost by laying 2.8 million blocks—perhaps four years' work.

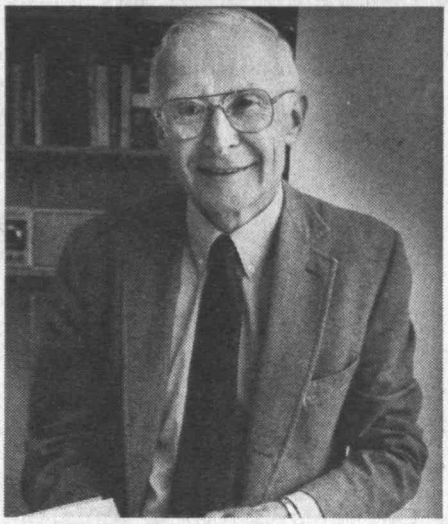
Then there was Studwelder, an automatic machine to weld the shear connectors that link concrete floors and decks to structural steel in buildings and bridges. Studwelder takes only five seconds to fasten a shear connector in place, and its $25,000 cost can be recovered by welding 400,000 shear connectors—for a major contractor, less than two years. (For Studwelder and the other construction robots, the average design-life is five years.)

Autonomous machines, Slocum believes, cannot operate without human intervention in the complex environment of construction. "All the little things end up killing you," said Slocum. "Only a human right on site can handle them."

Slocum's work also gave him a new sense of the importance of dimensions. Wallbot, for example, had to be able to erect a wall to within a fraction of an inch accuracy; given the scale of the job, that was often an accuracy of one part in several million.

Could the same kind of accuracy, wondered Slocum, be achieved at much smaller scales? He thought so, and he and his students proved it by designing A-Cal, a machine that calibrates accelerometers with an accuracy of 5 parts per million, ten times the accuracy achieved by the National Bureau of Standards, Slocum's sponsor. Now Slocum is working on a molecular measuring machine that may be able to map the atomic structure of biological materials.

Slocum calls this new field "precision mechatronic design"—structural design combined with dynamic and static analysis on very small objects. It's truly interdisciplinary: "You need everything—civil, mechanical, and electrical engineering," he said. The one common denominator of his work is the goal: "To get a machine to do what you want it to do no matter what its environment." □



BERNARD J. FRIEDEN:

Cities: New Role In Development

The trend of the 1960s that left central-city stores abandoned while investors poured money into suburban malls has been reversed. Now central cities are "in" again—old buildings refurbished, new stores everywhere.

Why this reversal? And what can we learn from it about managing future growth?

If there's a single lesson, says Bernard J. Frieden, Ph.D.'62, professor of city planning, it is the power of cities to take control of their destinies.

In the last decade decreasing federal funds for urban renewal have been replaced by unprecedented investments by cities, Frieden told an audience in Kresge Auditorium. To make possible new city-center shopping malls, cities have taken aggressive new roles by "wheeling and dealing with developers" in ways that violate the traditional arms-length relationships of a decade ago. Funding from philanthropic and business sources has been solicited to put in streets and utilities, assemble property, and develop parking sites. Cities are now taking the role of investors by financing these things themselves or bargaining with developers for reimbursement of costs or shares of future income.











CAMPAIGN

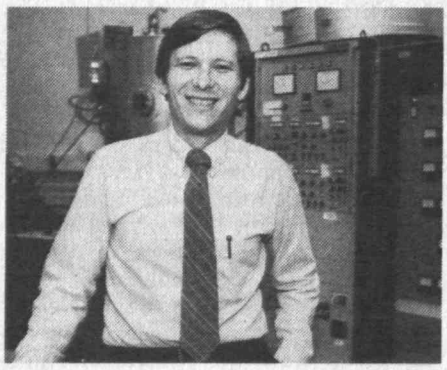
The Highlights

CAMPAIGN

The Faculty

CONTINUED

This trend in the use of public money has been hard to see because it has come in many forms and from many sources, says Frieden. But he is enthusiastic—an "imaginative" new role for cities, he says, especially because the cities have tied important social goals, such as targets for the employment of local residents and minorities, to their participation. □



DAVID RUDMAN:

Superconducting Ceramic Wires?

M.I.T. is only one of many institutions worldwide where physicists and materials scientists are working on superconductivity. Like David Rudman, the Esther and Harold E. Edgerton Assistant Professor in the Department of Materials Science and Engineering, they hope to find new zero-resistance materials or capitalize and expand on the properties of those available. (*See Trends, page 11.*)

And also like Rudman, they work amid swirling speculation about the potential uses of superconductors—everything from highly sensitive medical diagnostic instruments to "superconducting supercomputers." The former is within reach, Rudman told his audience; the latter is more remote.

In December 1986, the discovery of the first superconducting ceramic brought the critical temperature at which a known material will superconduct from 450 degrees below zero Fahrenheit to a new high of 390 degrees below zero. In relatively short order, scientists at the University of Houston announced the development of a new ceramic, yttrium barium copper oxide, which superconducts at about 280 degrees below zero, or 100 degrees Kelvin. Rudman acknowledges that 100 degrees Kelvin is not exactly balmy; but since that temperature can be maintained in the laboratory using relatively inexpensive liquid nitrogen, it represents substantial progress.

Superconductivity is not only limited by temperature, Rudman told his audience; it is limited in the strength of the magnetic fields it can tolerate. He believes that one key to developing a material that superconducts in a strong magnetic field lies in understanding the way that the crystalline structure of ytterbium barium copper oxide makes it anisotropic—that is, makes its properties vary with direction.

Rudman's group is working on a process for making thin films of the ceramic in which they control crystallographic orientation, and therefore control the direction in which the material will conduct. He predicts that these thin films, though difficult to make, will be especially useful in microelectronics.

The third vital parameter in the functioning of a superconductor is the maximum current at which it can operate. The critical current depends less on the chemical properties of a material than on the way it is made. Ceramics are brittle—next to impossible to wrap them into a wire.

But wires are what we need. Rudman credits Professor Gregory Yurek, an expert in high temperature oxidations, with the suggestion of a possible solution. Yurek's group solidified a melt of yttrium, barium, and copper into a metal wire which, though an alloy, still has some ductility and can be worked. They then allowed the wire to oxidize into a ceramic wire. A process of heating and then quenching caused the material to take on the right crystal structure.

If a noble metal such as gold, which neither oxidizes nor has any place in the crystal structure, is added to Yurek's initial melt, the end result is a ceramic/metal composite. In the composite, the two phases—the gold and the ceramic—are finely mixed, and it is possible that its mechanical properties will be determined more by the metal than by the

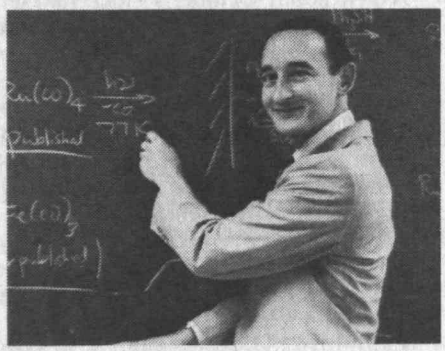


Snapshots from the festive campaign kickoff (left to right): space-age music in the Wiesner Building . . . Cecil H. Green, '23, honorary chairman . . . Vernon Alden with Laya Wiesner . . . Awaiting the speeches in Walker Memorial . . . Corporation chairman David S. Saxon, '41 . . . General chairman Carl M. Mueller, '41, (left) with Angus N. MacDonald, '46 . . . Beth A. Marcus, '79, with John W. Larson, '80, and William C. Rousseau, S.M. '36 (right) . . . Charles H. Smith, Jr. '42 with Professor Margaret MacVicar, '65 . . . William J. Hecht, '61, executive vice-president of the Alumni Association, with 1988-89 alumni president-elect Emily Wade, '45.

ceramic. The researchers are hoping to develop a final product that is tough, slightly ductile, yet superconducting.

But 12 months is not long. When asked when the new materials would be ready for applications, Rudman answered first with a monosyllable: "Oy!" While limited applications may appear quickly, broad use of the material could take much longer.—*Barri Gold, '88* □

BARRI GOLD, a senior majoring in physics, is a writing intern at Technology Review.



MARK WRIGHTON:

Molecular Transistors

"There are things that you can do in the biological world that you can't do within the framework of solid-state microelectronics—pattern recognition, a certain kind of memory, our senses," Professor Mark Wrighton, head of the Department of Chemistry, told his audience. "I submit that it is now possible to begin designing systems based on molecular materials that duplicate some of the functions of the biological world and maybe even improve upon them—and duplicate some of the functions of the microelectronics world and maybe improve upon those."

Wrighton discussed work going on in many areas in M.I.T. laboratories in a wide-ranging lecture it would be difficult to summarize in a few paragraphs. Notable was his speculation on biological chemistry.

Wrighton and his colleagues are concentrating on linking microfabrication technology with advances in chemistry. They have made, for example, a kind of "molecular transistor" switching device. It employs polymer molecules as bridges across gold or platinum contacts only one micron (millionth of a meter) apart. The change in conductivity of the bridge molecules, based on their charge, makes possible molecule-based switches.

The advantage of these kinds of molecular transistors is that their electrical characteristics can be dependent on the chemical environment. Wrighton told of a solid state polyanaline transistor that was protectively coated with a special chemically conductive polymer. The "chip" can measure the moisture content of gas, something quite difficult to do with conventional instruments.

"We now have the design principles in hand to make [moisture sensitive transistors] that respond to carbon monoxide, oxygen, nitrogen, carbon dioxide—in general to any gas phase molecule you can think of," Wrighton said. "Moreover, if we immerse these devices into solutions, we have methods for detecting the lithium ion in blood, oxygen—virtually any chemical in the biological or chemical world can be detected with these systems."

Asked whether molecular switching devices would replace semiconductor digital electronics, Wrighton said that he thinks that's very unlikely. "All [molecular] devices switch on the basis of real chemistry. What this means is that they are intrinsically slow, much slower than any solid state device. The fastest switching we see is 100,000 Hz; that's about what germanium transistors were doing 30 years ago.

"On the other hand, almost all of what we do is based on elementary [chemical] events that are very slow—even compared to the 100,000 Hz. So we've been thinking about developing a way of making a new kind of neural network where molecular materials make the connections and we can adjust both the distribution and the strength of the connections by changing the chemical environment in either the entire net or in local regions of the net."

It may sound science-fictional, but as Wrighton seems to suggest, M.I.T. researchers are opening a chemical pathway that may lead to mimicking the functions of biological brains.—*Eugene F. Mallove, '69* □

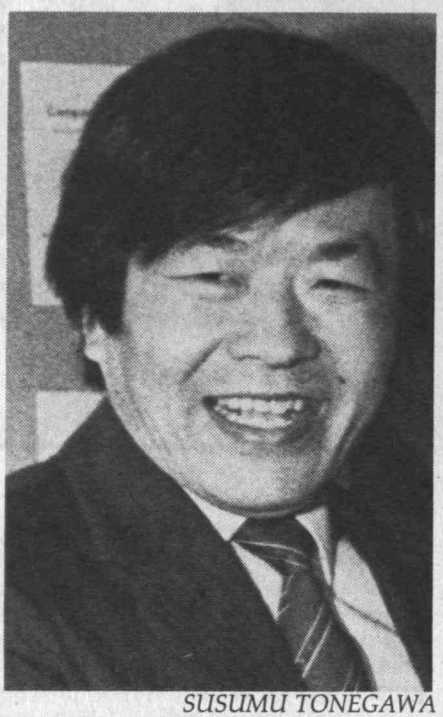
EUGENE F. MALLOVE, '69, is a science writer in the M.I.T. News Office.

PHOTOS ABOVE: DONNA COVENEY/L. BARRY HEATHERINGTON

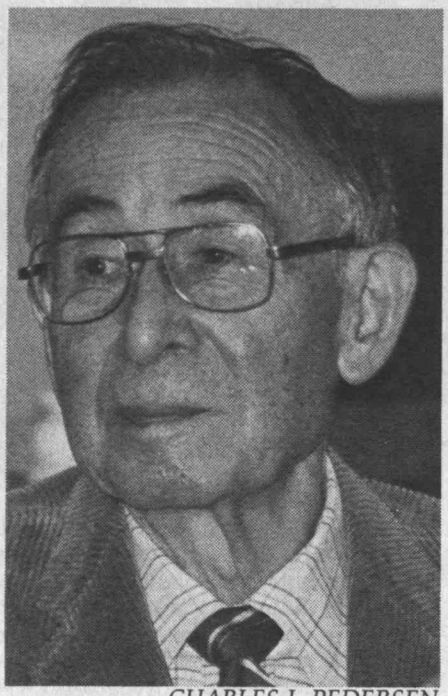
Two Professors, One Alum Win 1987 Nobel Prizes



ROBERT M. SOLOW



SUSUMU TONEGAWA



CHARLES J. PEDERSEN

Technology the Key to Growth

Every year his name has popped up," a member of the Nobel Prize committee told *The New York Times* after conferring this year's economics award. Now, 30 years after his seminal papers on economic growth were published, Institute Professor Robert M. Solow, is finally tasting the power and the glory that accompany a Nobel Prize.

A dyed-in-the-wool Keynesian, Solow wielded considerable influence during the Kennedy and Johnson eras. But in the age of Reaganomics, he has to stand on the sidelines of economic policymaking. Nevertheless, the award is "very timely," according to Lester Thurow, dean of the Sloan School of Management. Since the 1950s, Thurow said, American productivity has slowed from an annual increase of 3 or 4 percent to less than 1 percent. So the study of growth "is a hotter topic today than it was 30 years ago."

In its announcement of the prize in October, the Royal Swedish Academy of Sciences commended Solow for creating "a theoretical framework that can be used in discussing the factors which lie behind economic growth in both quantitative and theoretical terms." Specifically, he was cited for a pair of influential papers written in 1956 and 1957. In them he used intricate mathematical models to isolate the effects of different factors—such as capital, labor, and technology—on the growth of industrial economies. "The surprising conclusion," said Solow in a press conference at M.I.T., "was that technological change looms much larger than capital investment." In other words, he found that the key to growth is not *more* machines and factories but *better* machines and factories.

Since then, Solow's theories have reverberated around the globe. The World Bank uses his models to forecast national growth. And soon after it was published, according to Nobel committee president Assar Lindbeck, Solow's work led many governments to redouble their support for higher education and R&D. "Every long-term report I have seen for any country has used a Solow-type analysis," Lindbeck told reporters.

In Washington in the 1960s, Solow was able to translate his theories into political practice. Appointed to the Council of Economic Advisers by President Kennedy and to the National Commission on Technology, Automation and Economic Progress by President Johnson, he set national growth targets and helped formulate the interventionist Keynesian economic policies of both administrations.

Asked about October's stock market crash, Solow seemed to implicate an overdose of laissez-faire. He called the crash "an example of where a fairly free market is making movements that are not productive." But the worst problems right now, he told one of his interviewers, "are the trade deficit and the federal budget deficit, which are not unrelated." And there is no quick fix in sight. "It has taken years for us to dig ourselves into this hole, and it will take years for us to dig ourselves out."

Evidently, we will need a steam shovel. Consumption must drop, he said. The government must cut spending, raise taxes, and lower the dollar. As for wages, American workers must expect to fall behind their counterparts in some other industrialized nations. At the same time, though, plant and equipment investment must not fall. And that goes for research and education as well: "It would be a mistake to leave the unskilled, the uneducated, just hanging there." There are tough times ahead, he told reporters, but "there is no danger we're going to become impoverished."

Solow received a doctorate at Harvard in 1951. He was much influenced by his thesis adviser, Wassily Leontief, who himself won a Nobel Prize in 1973. Solow started teaching at M.I.T. in 1949, after he received his master's, and was made a professor of economics in 1958.

Through his books—*The Nature and Causes of Unemployment in the U.S., Capital Theory and the Rate of Return,* and *Growth Theory*—as well as more than 100 papers, Solow has gained a reputation for clear, uncluttered writing. Yale University professor James Tobin, who won the Nobel Prize for economics in 1981, told *The Wall Street Journal*: "He is one of the few economists in the world who can write good English—English that's fun to read even on technical subjects."

Understanding Immunity

How is it that a fan of sumo wrestling, a sport that epitomizes the struggle of the individual, also gets excited about baseball? In the case of Susumu Tonegawa, the 48-year-old M.I.T. molecular biologist who received the 1987 Nobel Prize for Medicine or Physiology, a clue may be found in his attitude toward science: While he cherishes individual enterprise and usually works alone, he recognizes that discovery builds on the efforts of many.

On the other hand, Tonegawa scorns the collaborative research culture of his native Japan. A Japanese research manager quoted in *The Wall Street Journal* remembers him from his student days as "a young, energetic guy who couldn't conform to anything." Soon after graduating from Kyoto University in 1963, Tonegawa left for the West. He received a Ph.D. from the University of California at San Diego in 1969 and did postdoctoral work at San Diego's Salk Institute. Then, in 1971, he took a post at the Basel Institute for Immunology. Ten years later, he came to M.I.T. as a professor of biology and researcher in the Center for Cancer Research.

Contrasting his experience in Japan and in the West, Tonegawa told an audience of young scientists in Tokyo earlier this year that they "must consciously reject authority and social convention." He said, "Is teamwork effective in creative research? My answer is no."

On the other hand, Tonegawa is quick to share credit for the pioneering immunology research that won him the Nobel Prize. In a series of experiments at Basel, he managed to explain the mechanism that allows a limited number of genes in the immune system to produce a virtually unlimited variety of antibodies for combating foreign invaders. He published his findings in 1976. For the next two years, said the Nobel committee, "Tonegawa completely dominated this area of research."

Only two other researchers—Earl W. Sutherland, Jr., in 1971 and Barbara McClintock in 1983—have been honored singly with the medicine prize in the last 25 years. But on learning of the award, Tonegawa told reporters at M.I.T. that he was surprised he had not been cited jointly with other biologists doing related work; in September, for example, he shared the prestigious Albert Lasker Medical Research Award with Philip Leder, of Harvard Medical School, and Leroy Hood, of Caltech.

In one experience with B-lymphocytes—antibody-producing cells—taken from mice, Tonegawa discovered that antibody genes in mature mice were closer together than in mouse embryos. Eventually, he and other researchers found that DNA segments in B-lymphocyte genes shuffle and recombine themselves, giving rise to a wide variety of different antibodies.

The significance of Tonegawa's work is far-reaching. It has helped researchers understand how the immune system sometimes goes awry, causing allergies or—as with diabetes—attacking the body itself. The Nobel panel said the work could also lead to better vaccines and to ways of minimizing the body's rejection of transplanted organs.

With the Nobel Prize—the first in medicine to go to a Japanese citizen—has come a flood of accolades from Tonegawa's colleagues. Quoted in *The New York Times,* David Raulet, an associate professor in M.I.T.'s Biology Department, called him "a brilliant problem solver . . . good at picking out the fundamental issue and figuring out a way to solve the problem quickly."—*David Brittan* □

DAVID BRITTAN, formerly copy editor of High Technology, *is a freelance writer and editor.*

These Molecules Are Choosy

It was in 1967 that Charles J. Pedersen, S.M.'27, found what he remembers as "a brownish goo . . . with an intriguing combination of properties." It was a by-product of his search for new catalysts in the laboratories of the Organic Chemicals Department of E. I. du Pont de Nemours and Co., Wilmington, Delaware.

It turned out to be the first synthesis of an organic material with the property that is now called "molecular recognition"—the ability to choose with which other molecules it will associate to form particular complexes, fitting together as a key fits a lock. Enzymes and hormones, which initiate their effects on cells by first coupling with specific structural parts of the cell, are examples of molecules with this property.

Pedersen and his associates were quick to realize that he was on to "something very unusual." For the rest of his professional career—he was 63 at the time—Pedersen devoted all his energies to the study of this fascinating class of materials. The rewards were many, including the ultimate: the Nobel Prize in chemistry for 1987.

Pedersen, now 83 and living in Salem, N.J., was born and raised in Korea. His father was Norwegian, his mother Japanese. He received a bachelor's degree in chemical engineering from the University of Dayton in 1926. M.I.T. Professor James Flack Norris, with whom Pedersen took a master's degree in chemistry, tried to persuade him to stay at the Institute for a doctorate, but Pedersen chose to go to work for du Pont. At du Pont Pedersen quickly showed himself to be "remarkably gifted at research," says Pedersen's most recent supervisor, Herman E. Schroeder.

Pedersen shared his Nobel Prize with two others who have pursued the original discovery—Jean-Marie Lehn, professor of chemistry at the Universite Louis Pasteur, Strasbourg, and the College de France, Paris; and Donald J. Cram, professor of chemistry at the University of California, Los Angeles. Twenty years of research by these and many other organic chemists have resulted in the synthesis of molecules that mimic the chemical reactions of the processes of life.—*John Mattill* □

BY PHILLIP TIETBOHL, '84

Orbis:
The Flight for Sight

One phone call from Steve Yoon, '83, began 1.75 of the most exciting years of my life. He phoned from China in July 1985 to see if I would be interested in taking over his position as biosystems engineer for Project Orbis, a nonprofit, international organization dedicated to fighting blindness.

Orbis operates a DC-8 jet outfitted as a teaching eye hospital that travels mainly to developing countries at the invitation of the local ophthalmic communities. Each three-week training mission covers the latest in eye surgery techniques and promotes primary eye care. Since its initial flight in 1982, Orbis has flown to more than 47 countries, treated 6,000 people free of charge, and supplemented the training of some 5,500 doctors.

As biosystems engineer for Orbis, I would be responsible for maintaining the medical and audio-visual equipment. An M.I.T-trained mechanical engineer ought to be able to handle that, I reasoned. So, four weeks after Steve's initial call I was on a 747 jet bound for Singapore, where I linked up with the Orbis plane.

The 29-year-old plane, which has now logged about 55,000 hours, was donated by United Airlines. From the inside, the plane no longer resembles a commercial jet liner, except for the 18-seat classroom where doctors watch surgery being performed in the modern operating theater via closed-circuit TV. In the front of the plane is an examination room where patients are seen prior to surgery; in the back is the recovery room.

A visiting surgeon from the United States, Canada, or Europe works side by side with a local doctor on every case. The chief surgeon wears a microphone clipped to his or her surgical mask and describes the operating technique while fielding questions piped in from the observing doctors. Communication is controlled by the production staff in the audio-visual room—a complete mini-television studio located behind the onboard classroom. On virtually every mission, I also set up a remote classroom in an airport building, complete with two-way audio, from which another 50 physicians observed the surgery.

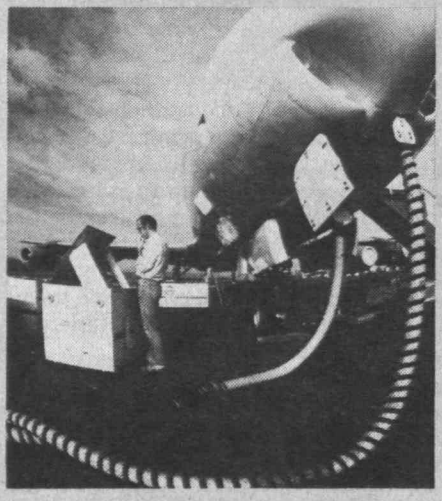
It Was 2.70 Every Day

As a staff engineer on a hospital that flies to a new location every few weeks, I never knew what to expect. Any day could be the start of a new "2.70 contest" (M.I.T.'s annual mechanical engineering design competition), with the plane being the traditional brown bag of parts, perhaps an airport sheet metal shop in Hong Kong serving as the basement of Building 3, and a request from one of the crew members filling in for Woodie Flowers' problem statement.

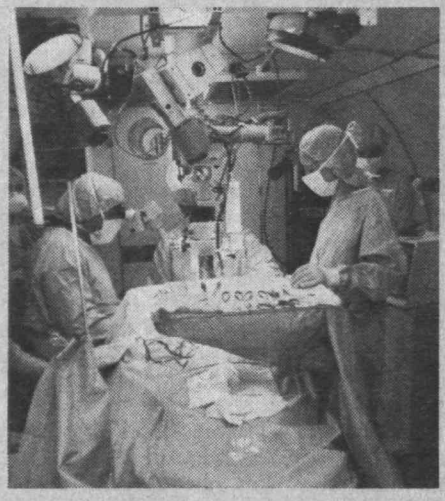
In Egypt, for example, the nurses asked for an extra I/V pole for the operating room. Three or four bottles had been hanging from the one pole we had, making it difficult to adjust. The floor-standing model available from any medical catalogue would have taken up too much space in an operating room sandwiched between the wings of a DC-8. So, with some plastic bar stock from one of the belly storage compartments and other spare parts and hardware, I constructed a pole with an adjustable clamp that could be hung from an existing ceil-



The author's job: operating technical equipment in this airborne hospital.



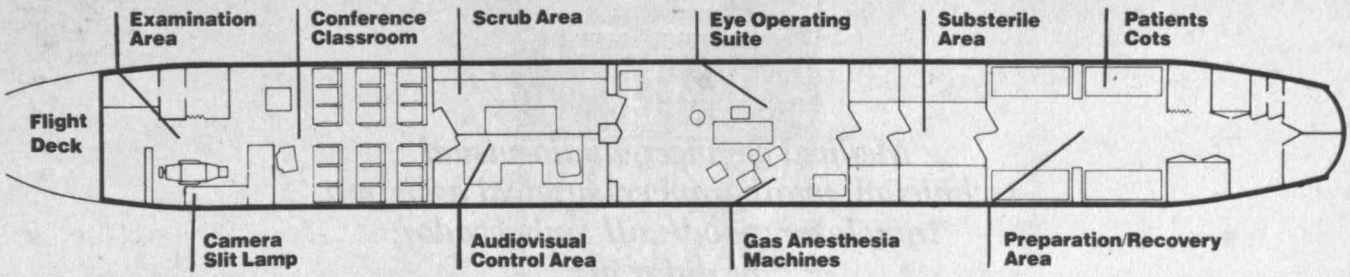
Orbis generators power a myriad of medical and technical functions.



Doctors and nurses are monitored by microphone and video camera. . . .

PHILIP TIETBOHL, '84, completed his tour with Orbis in April, 1987. William Walters, '86, is currently the Orbis biosystems engineer.

PHOTOS: JORDAN COONRAD/PHILLIP TIETBOHL



ing bracket. It's still in use.

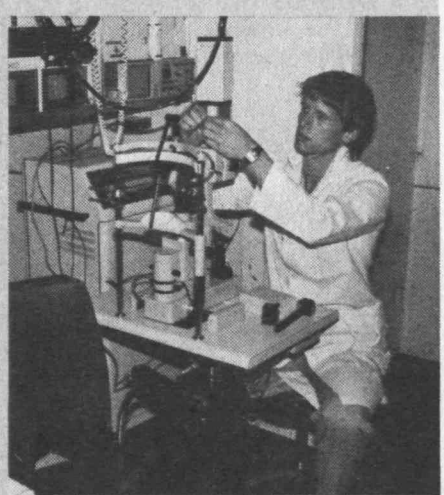
In Jamaica, I worked with a machinist from the airport maintenance hangar to make a video camera mount that would provide a side view of the patient's eye during surgery. The operating room already had six cameras: four cameras are fixed to the ceiling for overhead shots; another is mounted on an indirect ophthalmoscope that the doctors wear on their heads for examining the retina; and a camera is connected directly to the operating microscope and shows the same view the surgeons see as they look through the eyepiece. The shots from the new ceiling-hung side-view camera now enable doctors in the classrooms to study the angle of penetration of the surgeons' instruments.



. . . to be seen in the on-board classroom by local doctors and nurses.



Among Phil Tietbohl's responsibilities: computer trouble-shooter.



Tietbohl is required to service sophisticated surgical equipment.

Nothing if Not Flexible

I may have been listed as an engineer, but I filled many roles. Assisting the scrub nurse in the operating room, documenting the visits of local dignitaries as the 35-mm still photographer for our public relations department, and serving as an unofficial Orbis tour guide for anyone from airport workers to ambassadors could all be in a day's work. In Central and South America, my gradually improving Spanish was called on to explain to ambulance drivers when they should return to pick up the patients or to reassure a patient's relatives that the surgery was going well. My handiest "surgical" tool was a Swiss army knife.

Working inside a fuselage that is only 110 feet long and 13 feet wide—packed from cockpit to tail with the 18-member Orbis crew, 20 local doctors, six local nurses, three visiting surgeons, a local TV crew with cameraman and reporters—was always hectic. A simple repair that should take only 10 minutes could take hours. Gaining access to a tool cabinet in the exam room, locating a pair of aircraft ear protectors, finding a part in one of the storage compartments in the plane's belly, changing clothes as needed to pass between sterile and nonsterile areas, and finding a clear working space could be major undertakings.

The ordinarily high level of stress associated with hospital jobs was aggravated on Orbis by cramped quarters, misunderstandings owing to different languages, and the ever-present whine of our generator. When the generator finally spun down at the end of the day, the silence was a welcome relief. Only then, as my face muscles relaxed, did I notice that my jaw had been clenched tight for most of the day.

Luckily for our stress levels, not every day was spent on the plane. On Mondays, while the Orbis medical staff screened patients for surgery, I often visited local hospitals to work on equipment. In many developing countries, no one is responsible for maintaining medical equipment. Things as simple as loose wires and burnt-out bulbs can idle sophisticated machines for years.

Even if I didn't have the parts or the experience to make needed repairs, the doctors and nurses were so grateful that I understood their problems and tried to help. In Ecuador, one week after I had spent a 10-hour day trying to fix a microscope at one of the local hospitals, four nurses whom I had met there gave me a colorful T-shirt. They had waited in the hotel lobby for more than two hours to deliver the shirt, because we had worked particularly long hours on the plane that day. I was moved beyond words.

Evenings offered the occasional recep-

Medical engineer, audio-visual technician, photographer, surgical assistant, translator, good-will ambassador; he did it all.

tion at the American Embassy, dinner with local doctors at their favorite restaurant, or a birthday party for a crew member. On Saturdays, we might play baseball or soccer with the local medical team. And on Sundays, I usually toured the city on my rollerskates, drawing strange looks from passers-by.

In Lima, my skates drew smiles from a group of policemen and military guards as I zipped around the plaza behind the president's palace. In Kathmandu, huge crowds of people surrounded me in the streets and watched with broad grins as I spun in circles, waiting room, desperately hoping that the Orbis doctors will treat them, was depressing. The saddest part is that many of these people might not have been there if they had known and followed some basic rules of hygiene or taken simple precautions against accidents.

But there were exhilarating moments as well. I recall watching a Guatemalan doctor performing his first interocular lens implantation—the replacement of a natural lens rendered opaque by cataract disease with a plastic lens—and feeling his excitement at having learned and heads of state or ministerial-level officials of the countries we visited on board the plane to discuss what they could do to prevent or cure blindness among their own citizens.

In Peru, strict laws regarding the removal of organs from the body were relaxed after the president witnessed a corneal transplant on board Orbis in 1983. During the next visit to Peru in the fall of 1986, we learned that more than 250 corneal grafts are now being done there each year.

The presidents of Costa Rica and Malta signed donor cards for their cor-



Heading home with much improved vision, Orbis' raison d'etre.



Guards in Columbia sometimes toted oxygen tanks or helped patients.

hoisting children in the air, putting on a little show. In Istanbul, I was pulled around a square at high speeds by a group of excited children.

Witnessing more than a thousand eye operations has made me intensely aware of how fortunate most Westerners are to have good vision and medical care. Forty-two million people in the world cannot see, and a half a billion more, mainly in Third World nations, are threatened by potentially blinding diseases.

Watching hundreds of people with severe eye problems packed into a hospital demonstrated a new technique on live TV. Many times I shared a patient's elation upon regaining his or her vision when eye patches were removed a few days after an operation.

Orbis not only treated the blind, it also tried to have a lasting impact on eye care. In Aeriquipa, Peru, I helped show 40 kindergarten teachers how to use eye charts, so they could screen their classes each year and refer those children with problems to a doctor for treatment. In Nepal, we traveled outside Kathmandu to remote villages to gather information for a public health survey. We brought neas in the Orbis recovery room, in front of the cameras of local media, to help motivate their citizens to do the same.

The experience on Orbis has opened up many possible pathways for my career. That's exciting, but it also makes the choice of a single area of interest more difficult for me. I'm wrestling with a decision about my next career move right now.

The nurses with the T-shirt, taught me that worldwide understanding can be practised on a wonderfully personal level, and I'm sure that will stay with me all my life. □



UNDER THE DOMES

Record Funds, Small Surplus

M.I.T. operating expenses were a record $882.5 million in 1986-87, 11.4 percent over the previous year. And the Institute had a modest surplus of $1.2 million on the year's operations when fiscal 1987 closed last June 30. It was the fourth consecutive year in which a fraction of unrestricted gifts remained after all expenditures had been covered by available revenues—tuition, investment income, research revenues, and gifts.

Two major milestones were passed during fiscal 1987, according to the report of James J. Culliton, vice-president for financial operations, and Glenn P. Strehle, '58, vice-president and treasurer:

□ Gifts came to $68.3 million, 25 percent higher than in the previous year. "The inflow of gifts is rising faster than the rate of inflation," said Culliton and Strehle, "and the 1986-87 total is more than three times that of just eleven years ago."

□ Total investments of the Institute stood at almost $1.4 billion (market value). Of this total as of June 30, 1987, $1.17 billion was endowment.

As in the previous three years, a portion of unrestricted gifts were used to meet current expenses in fiscal 1987—in this case $3.125 million of the total of $4.275 million in unrestricted gifts, grants, and bequests. Thus only $1.150 million of unrestricted giving was available for discretionary use, including adding to endowment. □

"One More Than Others": M.I.T.

Surveying the sources of New England's economic boom, Britain's distinguished journal *The Economist* gives major credit to M.I.T. "In Massachusetts," wrote author Matt Ridley in a special report (August 8), "one university matters more than all the others: M.I.T."

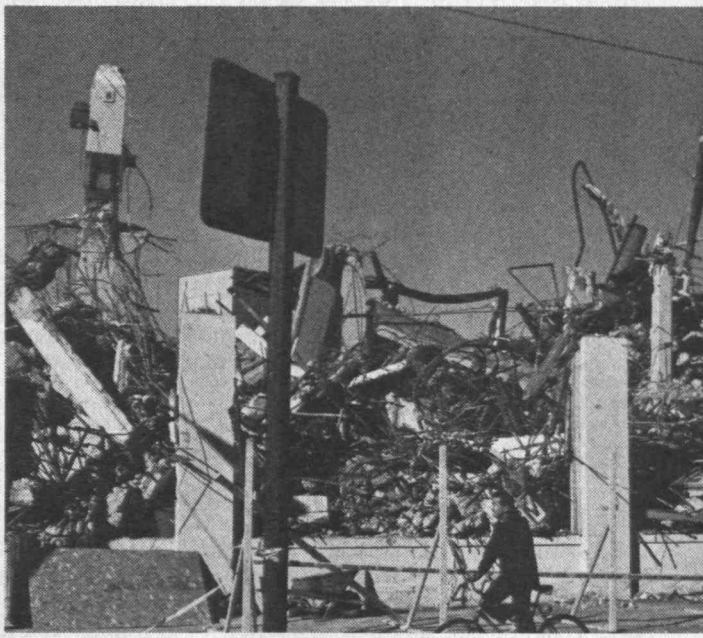
Here is the rest of Ridley's tribute to M.I.T.:

"In the past decade, it has distributed flocks of graduates and professors along the freeways of Massachusetts, each one hoping to reproduce the miracles of his predecessors—and many succeeding. As some cynics put it, where Harvard MBAs build companies by mergers, M.I.T. engineers build them from scratch. Raytheon, the radar company that invented the microwave oven, went back to M.I.T. for talent again and again. Mr. Charlie Adams, a scion of an old New England family who built Raytheon into Massachusetts' largest industrial company, says he would hire an M.I.T. engineer rather than a Harvard MBA every time. Having M.I.T. in the backyard was essential to his company.

"How does M.I.T. manage it? For a long time, it stood virtually alone as a university that embraced rather than shunned industry. Ever since W. Barton Rogers founded an institution to 'respect the dignity of useful work' in 1861, M.I.T. has seen its role as industry's talent spotter. It established many of the ground rules—for example, its professors can spend one day a week on outside business—that other universities had to sort out when biotechnology arrived in the 1980s. Starting a business became not just acceptable, but almost expected of a bright graduate student in electrical engineering.

"M.I.T., unlike Harvard, is not a pretty campus. It used to be said that you could tell which way the wind was blowing by whether the smell came from the chocolate factory or the meat plant. Now the heavy industry of east Cambridge is disappearing in a rush of redevelopment that will fill the district with glossy shopping malls and hotels. At present, though, the area east of the university is the site of the extraordinary mushrooming of companies in artificial intelligence. They call it AI Alley and the people who work here are known as "hackers." Besneakered and T-shirted, they work all hours of the night and some of the day as well, hunched over flickering Lisp machines trying to work out how to make computers clever.

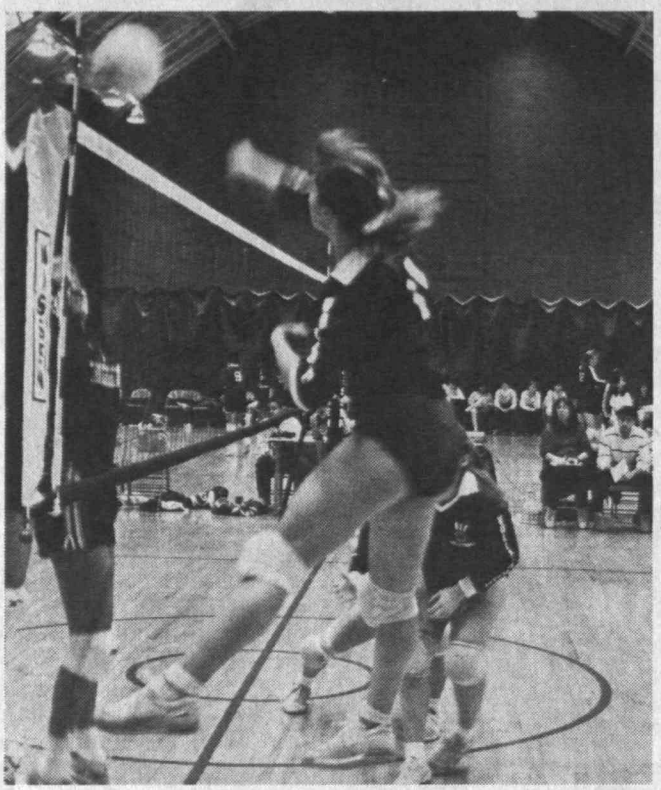
"Not much artificial intelligence has been brewed here yet. The biggest fortunes have been made by hackers selling each other the tools of the trade. Sym-



After decades as M.I.T.'s nearest neighbor to the northeast, the TRW fastener factory was reduced to rubble late last fall.

Coming on the site: a new biology building that is a major goal of the $550 million **Campaign for the future.**

PHOTOS: SARATH KRISHNASWAMY, '91, THE TECH



Cecile Warpinski, '90, put this one away against Wellesley during her team's successful quest for the 1987 New England Women's Volleyball Championship on November 7.

bolics, which makes Lisp machines just across the road from M.I.T., achieved $114 million of sales in its sixth year of existence, 1986, but has since had to retrench in the face of competition from Sun Microsystems in California. Four hundred yards away, Thinking Machines makes Connection Machines, sinister black boxes that are to computers as cars were to bicycles.

"Thinking Machines typifies the bold risk-taking that makes New England work. In 1983, Miss Sheryl Handler, who knew nothing of computers but lots about setting up companies, persuaded some of science's brightest brains to join the board of a company whose aim was to make a computer think—however long it took. She also persuaded some wealthy individuals to put up the money, and grabbed a visionary graduate student from M.I.T. called Mr. Danny Hillis. Three years later, she was selling the Connection Machine, which does not actually think yet. But if anybody can work out how to program it to do so, Hillis probably will." □

McBay Heads Minority Plan

Shirley M. McBay, dean for student affairs at M.I.T., is chair of a resource group for a new national coalition on minority education that has won $1.18 million in funding from the Carnegie Corp.

The goal, she says, will be "to develop a comprehensive plan to focus on the education of minorities who, as a group, have been left out of our educational system, our economy, and our society." With the plan completed, the group is expected to evolve into a nonprofit foundation to fund and carry out its goals.

McBay was director of the project on "A Blueprint for Action for the Educational Minorities," whose proposals led to the Carnegie grant. Professor Kenneth R. Manning, chairman of the Writing Program at M.I.T., is among 14 experts from throughout the U.S. who are members of the resource group that McBay heads. □

Bridging the Faculty Gap

How often does a member of M.I.T.'s Chemistry Department—for example—talk to colleagues in the Sloan School of Management? Or a computer scientist in the Artificial Intelligence Laboratory to a member of the Political Science Department?

The answer to both questions, of course, is seldom.

And that is bad, says Professor Margaret L. A. MacVicar, '65, dean for undergraduate education. "If we are going to talk about an integrated education for students," she says, "the base condition for that is an integrated faculty, a faculty with a common purpose and outlook."

As a first small step in that direction, MacVicar has for the last two years spearheaded a program of cross-disciplinary week-long summer mini-courses in which faculty teach faculty. In the first year Professor William M. Siebert, '46, gave an intensive mini-course in computer programs for members of the School of Humanities and Social Science, and political science Professor Robert I. Rotberg organized a mini-course on contemporary world problems for engineering faculty. Last year the experiment continued with intensive courses for science and engineering faculty on biotechnology by Professor Vernon M. Ingram and on literature by Professor Alvin C. Kibel.

Rotberg's course received rave reviews: "It was great!" wrote one faculty/student. "Loved it!" said another. "The great value in the seminar was in getting to know five persons from the School of Humanities and Social Science," wrote a third.

The same reaction awaited Professor Kibel, after his four-day study of the *Odyssey* that included reading by his faculty class of both the original and James Joyce's novel *Ulysses*. It was an exploration of the place of the epic in culture and what it can reveal about a society from which it comes, conducted for some 45 members of the Schools of Engineering and Science. "A howling success," says Kibel. He found "a great appetite for serious, disciplined discussion" of such literary works, and he hopes to repeat the course next summer. Indeed, says Kibel, he is convinced that an organization devoted to faculty renewal of this kind is badly needed at M.I.T.

MacVicar is delighted with these activities, which were launched by a $150,000 grant from Exxon Education Foundation in 1986. The proposal to Exxon explained why the mini-courses are needed: If the faculty remain narrowly focused in their interests and contacts, "there is not only little chance of basic curricular reform, but also little chance of changing the underlying student culture and perceptions about the humanities and social sciences." □



CLASS NOTES

18

As is usual at this time of the year, there is a dearth of class news. The one bright event was the meeting of the Cardinal and Gray Society at Endicott House September 13, 1987. You will recall this organization came into being as a successor to our annual get-togethers at Endicott. As our numbers decreased, it was decided to change the event to include all classes out over 50 years. Last September's meeting had an attendance of over 80 M.I.T. alumni including spouses and guests.

The speaker for this occasion was Hank Spaulding, '51, founder of the Real Estate Development Master's Program at M.I.T. and a well-known architect and developer. Not only did he head up this newest course at M.I.T., but through his connections in the industry made it self supporting. The Real Estate Development Center at M.I.T. was the first in the country to offer a master's degree in that field and has already graduated developers who are having an impact on the Boston community and elsewhere.—**Max Seltzer,** Secretary, 865 Central Ave., Needham, MA 02192; **Leonard I. Levine,** Assistant Secretary, 519 Washington St., Brookline, MA 02146

19

We regret to report the death of two more of our classmates: **Arthur G. Kenison** of Northville, Mich., died on April 19, 1987; and **James M. Strang,** of Pittsburgh, Pa., in July 1987. We hope to have more complete information for our next *Review* notes.

With kind regards for all '19ers.—**W. O. Langille,** Secretary, P.O. Box 144, Gladstone, NJ 07934

20

Notice of **Bill Dean**'s death on July 18 last year comes via the Alumni Office. His home was in Amherst, N.H. He leaves his wife Amy.

Ken Newhall died on April 13 last year. His home was 25 Rock Ave., Swampscott, Mass. Ken, a civil engineer, supervised renovation of buildings and new construction at Harvard University. Retired in 1962, he served as clerk of the works at Merrimack College. Early in his career, he laid out all water and service lines for Boca Raton, Fla. He was a member of the reserves of the U.S. Coast Guard. He leaves a son, a daughter, and five grandchildren. . . . **Bob Burchell** died last year. He lived at 136 26th Ave., N.E., St. Petersburg, Fla.—**Harold Bugbee,** 313 Country Club Heights, Woburn, MA 01801

21

The Alumni Records office reports six deaths this month: **Henry A. Alter,** Waterbury, Conn., 1986; **Edward F. Praetz,** Lawrence, Mass., February 14, 1987; **Reginald H. Smithwick,** Jupiter, Fla., February 27, 1987; **Morris F. Sheldon,** Carmel, Calif., May 21, 1987; and **Henry R. Kurth,** Falmouth, Mass., August 9, 1987.

Ed Praetz was head of the Mathematics Department at Lawrence High School and also taught at Merrimack College. He received a master's degree from Harvard College. Ed served in World Wars I and II.

Reg Smithwick was active in undergraduate affairs at M.I.T. and served as class president in our senior year. He went on to Harvard Medical School and got his M.D. in 1925. Reg pioneered in treatments for both essential and malignant hypertension, treatment of vascular disease and management of peptic ulcers and diverticulitis. He received graduate surgical training at Massachusetts General Hospital and became surgeon-in-chief at University Hospital in Boston. His was a distinguished career.

Chick Kurth worked at Boston Edison for 44 years, being named vice-president in 1956.

Phone calls to **Cac Clarke** and **Irving Jakobson** in late September brought forth a little news. Cac is doing well after his minor stroke reported earlier, but hasn't gone back to working at his office as yet. He reported receiving a letter from **Don Morse** telling of the recent death of **Edmund J. MacDonald** of Needham, Mass., on September 23, 1987. Ed was a loyal and generous member of the class of 1921. Cac also reported a phone call from **Helier Rodriguez**—no special news from him or Graciela. Ruth and Irving Jakobson are both doing well and leading an easy life. Jake no longer sails his boat.

Happy New Year to you all.—**Sumner Hayward,** Secretary, Wellspring House E64, Wash. Ave. Ext., Albany, NY 12203; **Samuel E. Lunden,** Assistant Secretary, 6205 Via Colinita, Rancho Palos Verdes, CA 90274

22

The *Hartford Courant* in January 1987 had an interesting article about our classmate **Arthur L. Wasserman** who is chairman of Wasserman Mechanical Systems Removal, a company specializing in the removal of industrial processing equipment such as big boilers without knocking down the building. In 1928 Wasserman with partners became a wholesaler of heating apparatus under the name of Marsden and Wasserman, Inc. By 1965 he was sole owner with his son Alan as vice-president. Marsden and Wasserman was sold in 1985 after which the present company was started with Wasserman as chairman, Alan president and third generation Larry as vice-president and secretary. Alan is quoted as saying, "(My father) Arthur is probably one of the oldest living professional engineers in the state."

In the November/December issue, the death of **Wilbur J. Woodruff** was noted. I now have some information about his career. Born in Buffalo, N.Y., he attended the U.S. Naval Academy before coming to M.I.T. as a junior. In 1923 he received his master's degree. He was a lieutenant commander in the U.S. Navy during World War II. Woodruff had been employed by Combustion Engineering as St. Louis district manager. He had served as chairman of the St. Louis Society of Mechanical Engineers, president of Experience, Inc., served on the board of the St. Louis Engineers Club; and was a member of the First Presbyterian Church of Kirkwood, Mo., and the Men's Garden Club of Kirkwood.

Belated word has been received about the death of **Lawson T. Blood** on September 1, 1986, in Arlington, Va., at age 88. Blood, Course XV, whom we knew so well as "Gyp" prepared at Taunton High School, entered M.I.T. as a freshman, became a member of Delta Tau Delta and was active in athletics, football, crew and basketball. At the time of retirement he was petroleum engineering officer with the Department of the Army in Washington, D.C. He is survived by his widow to whom we extend our delayed condolences. —**Yardley Chittick,** Secretary, Rte. 1, Box 390, Ossipee, NH 03864

23 65th Reunion

Edwin Schmitz died November 20, 1984. He graduated with our class in business and engineering administration. After graduation he was employed by the Union Fork and Hoe Co., Columbus, Ohio, and rose to treasurer, director and president. He was a past president, New England Wholesale Coal Association and Package Machinery Manufacturing Association. His recreation was golf.

Robert Stuart died October 3, 1986. He received a B.S. in mechanical engineering from the University of Michigan and graduated with our class in business and engineering administration. After graduation he joined the Charles Eneu Johnson Co. of Philadelphia and became secretary and director. He was president of the board of trustees, Upsala Foundation of Philadelphia. His hobby was collecting antique furniture and silver.—**Richard H. Frazier,** Secretary/Treasurer, 7 Summit Ave., Winchester, MA 01890

24

We must deflate the myth that all class secretaries are indestructible human beings. Russ, my co-secretary, was hospitalized by a heart attack last September 17 and decelerated further by a malfunctioning right hip and leg which led him over hurdles 67 years ago.

Don Moore will spend the holidays from Thanksgiving to New Year's on the West Coast visiting daughter professor Sandra Faber. . . . **Don Fife** continues to dig for clams on Cape Cod, frequently driving to Boston on business. **Ray Lehrer** and Dot have closed their Maine rejuvenation area and returned to their posh home town of Weston, Mass., to fight Boston's proposal to establish a trash dump in that area.

We have a note from Ginny Taylor, daughter of **Edward A. Taylor,** that he died February 24, 1986, in Pocono Lake Preserve, Pa. He was awarded an S.B. in business and engineering



The Corporation Development Committee's Marshall B. Dalton, '15, Award for resource development activities was given to Karl R. Van Tassel, '25, on October 23. Corporation Chairman David S. Saxon, '41 (left), called attention to Van Tassel's half-century of services to M.I.T.—"a distinguished record that encompasses the full range of volunteer service to the Institute."

Responding, Van Tassel said that alumni service "generates its own satisfaction." When you work for M.I.T., he said, you help replenish the resources that nurtured you and other alumni as students and at the same time you help support the future. "Like chopping wood," said Van Tassel, "it warms you twice."

administration, after preparing at Haverford College. He became manager of the engineer laboratory of the Bond Crown and Cork Co., Wilmington, Del. Ted was a member of Honorary Theta Tau, Corporation XV and the Mechanical Engineering Society.

We are in receipt of a note from Betty L. Wilson, a friend of Mrs. Jane Davidson, who reports Mrs. Davidson's death on April 23, 1987; and also **Elliot B. Davidson**'s death, belatedly, on December 31, 1982, in Calimesa, Calif. Dave was awarded a S.B. in mechanical engineering and became a sales and mechanical engineer, later joining the Propulsion Laboratory, Naval Air Missile Test Center, Point Mugu, Calif. He was a marine engineer, lieutenant, U.S. Maritime Service, European Theater of Operations in 1943-1946. He was awarded a "T" for four years on the basketball team.—**Russ Ambach**, Co-secretary, 216 St. Paul St., Brookline, MA 02146; **Rock Hereford**, Co-secretary, Hacienda Carmel #90, Box 5397, Carmel, CA 93921

25

Jesse Maury recently completed his 8-year term as a commissioner on the Washington Suburban Sanitary Commission (WSSC). The commission serves 1,300,000 people in the Maryland suburban counties of Montgomery and Prince George's. Jesse was one of the three commissioners from Montgomery county. In his farewell speech on August 21, 1987, Jesse outlined some of the accomplishments of the WSSC during his term of office and they were many. Of particular importance is the assurance of adequate water supply and sewage treatment well into the next century. Jesse has been in the field of personal financial planning for many years. The WSSC work has required about 20 hours a week so now he will be able to devote more time to his business. He has all of his commercial accounts on the computer and has added word processing to aid in composing his reports.

In September and early October Elinor and **Sam Spiker** spent three weeks in Switzerland, Spain, and England visiting friends.

It is with sorrow that I report the passing of two classmates. **John P. Sawyer** died at his home in Dorset, Vt. on March 10, 1987. Following college he joined the International Paper Company, where he managed paper mills in Cornerbrook, Newfoundland, and Orono, Maine, before moving to the company's New York City headquarters. After 35 years with the International Paper Co., he retired in 1960 as divisional sales manager. John and his wife Gladys were early pioneers of skiing; he was instrumental in the initial development of Stratton Mountain. John is survived by a son, a daughter, and five grandchildren.

Eugenia Dritsas of Branford, Conn. died on June 21, 1987, at the Fowler Nursing Center in Guilford, Conn.—**F. Leroy "Doc" Foster,** Secretary, 434 Old Comers Rd., P.O. Box 331, North Chatham, MA 02650

26

Evelyn and **Bob Dawes** and **Marvin Pickett, Jr.** braved the rain for the September Cardinal and Gray Society meeting. Bob is still a hard working businessman and Marvin still takes in symphonies, but won't be bothered with the "trash" of the Pops.

John H. Wills, of Colorado Springs, Colo., and St. Petersbury Beach, Fla., wanted his parents remembered in connection with his attendance at M.I.T. This past December he established the John J. and Anna Grimm Wills Memorial Scholarship Fund. "M.I.T. has maintained its high standards over generations," Wills says, "and I know that will continue." He is proud to be able to help others get an M.I.T. education.

As reported in Tech's Campaign Report, **Bill Meehan**, whose work for the class is outstanding, died Sept. 16, 1987. In spite of his eye troubles, he kept class news going and performed a miracle getting the book outlining the activities of the cooperating classmates published prior to our 60th reunion. Bill worked as an engineering consultant up to the very last moment.

Kathleen Hind writes from Rockport, Mass., "I am sorry to report the death of my husband, **Malcolm S. Hind** on May 25, 1984, after a long illness" . . . **Frederick P. Boughton** died November 6, 1986, from injuries suffered in an auto accident. He was living in Philadelphia where he retired in 1970. Formerly he lived in Marblehead and Swampscott, Mass. He attended all our reunions, including the 60th. . . . **Arthur B. Keay** died August 4, 1987, in Plymouth, Mass. He was with Stone and Webster Engineering Corp. until his retirement in 1971. Since then he has been freelance engineering. He died unexpectedly. . . . Please write to tell me what you are doing. On September 28th I will be calling some of you on the M.I.T. Telethon regarding donations. I enjoy our conversations during these calls.—**Donald S. Cunningham**, Secretary, 27 Lowell St., Braintree, MA 02184

27

President **Harold (Bud) Fisher** is pleased to report that **John B. Drisko** has accepted the office of vice-president and estate secretary of our class. At a wrap-up meeting of the reunion committee on August 26, Johnny was unanimously and enthusiastically endorsed. There are not many classmates who do not know him. He was on the Institute Committee and in the Glee Club and attended ROTC camp at Fort Humphreys in the summer of '26. A modest, quiet hard working civil engineer, his greatest achievement is his work on the design, construction management and final report of the huge (9,000 ft. long, 470 ft. high) Tarbell Dam in Pakistan. He and his wife Denny now live in Easton, Pa.

Horace R. Dyson died on May 14, 1987 in Westbrook, Conn. He was a radio bug and during his M.I.T. years was operator/announcer at WBZA Boston. During 1927-1930 he was head of the broadcast design section at Westinghouse, Chicopee Falls. In 1930 he started with RCA in Camden, N.J. where he stayed for most of his distinguished career: through 1948 as head of government transmitter section, from 1945-1951 as manager of government radiation engineering section, and in 1951 he became technical administrator of defense engineering. He travelled extensively and was a respected authority in his field. He was awarded the Civilian Certificate of Commendation by the U.S. Navy. He was official State Department delegate to the communications convention in London in 1950. He also enjoyed

PHOTO: DONNA COVENEY, NEWS OFFICE

flying his own plane and held both a private and certified CAP pilot licenses. Our sympathy is extended to his wife Eleanor and family.—**Joseph C. Burley**, Secretary, RFD #3, Epping, NH 03042; **Lawrence B. Grew**, Assistant Secretary, 21 Yowago Ave., Branford, CT 06405

28 60th Reunion

Editor's note: After your secretary wrote this column and as we were sending it to press, we received word of the death of **James Donovan** on October 16, 1987. See the obituaries section of this issue, p. MIT 43. **Walter Smith** has dedicated his next column to your beloved class president.

Can you believe it? Here it is, 1988, the year of our 60th Reunion! Our '28 reunions always have been such wonderful events, and this one promises to be no exception. If you can possibly make it, plan to attend! That worthy triumvirate—**Bill Hammond**, **Nap LaCroix**, and **Dick Hildick**—tried hard to arrange for a few days of meeting last summer but were unable to work it out. Now they are looking forward to the 60th with added enthusiasm. . . . Dick has been in telephone communication with **Jack Rouleau** also.

In the 1930s the only regular nonstop transatlantic air travel was aboard the great zeppelins. A crossing (in luxury) took two and one-half days. It all ended when the giant *Hindenburg* exploded on May 6, 1937, as it came in for landing at Lakehurst, N.J. During that long ago era of aviation, **Harold Dick**, then a young engineer from Goodyear-Zeppelin in Akron, Ohio, was at the Zeppelin Co. in Germany. Harold, with coauthor Douglas H. Robinson, has written a book, *The Golden Age of the Great Passenger Airships, Graf Zeppelin and Hindenburg*. We are reminded that the book is now in its second printing by the Smithsonian Institution Press.

We hear that Pam and **Rene Simard** took a two-week bus tour last summer covering some 2,000 miles of travel through Germany, Hungary, Czechoslovakia, and Poland. . . . A letter from Marie and **George Chatfield** gives us the news that last June their son, Dr. Donald F. Chatfield, married the Reverend Judith E. Lane, then associate minister of the Dover, N.H., Congregational Church. They met when Don, himself a clergyman, was teaching a course where Judy was his "prize pupil." It is a second marriage for both and promises to be a most happy one. George had a bout with pneumonia last April, then Marie had a bronchial infection. Happily, at the time of writing, both reported to be back in "normal fighting trim."

We have some miscellaneous short notes that came with reunion response cards. **Mariano Contreras**, writing from Venezuela, says that he lost his wife in 1985 after 55 years of marriage. His own health is good, he does traveling and looks forward to meeting again with classmates at the 60th. . . . **Al Gracia** says, "Had a new valve job (mitral, that is) in November 1986. All is well." . . . To **Bill Shenk** we send congratulations on his election to fellow in IEEE. Bill reports that they still spend summers on Cape Cod to enjoy swimming and to be near their families. . . . Gracia and **Tom Harvey** celebrated their 58th wedding anniversary last June by attending graduation exercises at Northwestern University, Evanston, Ill., when grandson Craig received his M.S. in industrial engineering. . . . **Eleanor Pepper** is working hard as ever but enjoying life. Like so many others, she is looking forward with great anticipation to June and the 60th.

A September meeting of the Cardinal and Gray Society at Endicott House took place on a wet day, but the rain failed to dampen the spirit of those gathered indoors. Hank Spaulding, '51, gave a talk about the M.I.T. Real Estate Development Masters Program. A lively discussion followed.

Those attending from '28 were Marjorie, widow of **John Carvalho**; Julia and **Paul Martini**; and Florence and **Walter Smith**.

It is with deep regret that we must report the following class-related deaths. **Leon P. Gaucher** died June 26, 1987. Leon graduated in Course I, civil engineering, but quickly became involved with chemical engineering upon entering the petroleum business right after graduation. He retired from Texaco, Inc. in 1969 after 41 years of engineering, research, and management service in the industry. Besides wife Catherine, Leon leaves his son, Donald. . . . **George Allan Holderness, Jr.** died April 17, 1987. George was a 1923 graduate of the U.S. Naval Academy at Annapolis who joined our class to earn his master's degree in Course XIII-A, naval construction and engineering. After a distinguished career with the navy, he retired in 1958 with the rank of rear admiral.

We must report also the passing of two class widows. Vivian, widow of **Isiah A. "Ike" Bullard**, died August 25, 1987, in Winchester, Mass.; Florence and I attended the service. Ike died in December 1973. . . . Mrs. **Edward S. Thompson** was reported by her family as deceased in 1987.—**Walter J. Smith**, Secretary, 37 Dix St., Winchester, MA 01890

29

Edward B. Papenfus of Vancouver, Canada, has now fully retired but does a little gardening and takes a daily walk. He also manages portfolio investments for his wife, son, and himself. He takes occasional motor trips but has not taken overseas trips for two and a-half years. He has three children and two grandchildren. His hobbies include stamp and coin collecting.

J. Wesley Walters of St. Paul, Minn., and his wife Josephine, in celebration of their 58th wedding anniversary, took a "super" motor trip of the U.S. and Canada. They left on Wes's birthday, went through the Black Hills of South Dakota, the beautiful high plateau west of Sheridan, Wyo., through Yellowstone National Park, through the "Craters of the Moon," Sun and Salmon River Valleys of Idaho, along the shore of Flathead Lake in Montana, then into Canada though British Columbia up to the Alaskan Highway to Edmonton, Alberta, through Glaciar Park and then home—a trip over 5,000 miles.

Joseph Green of Coconut Creek, Fla., and his wife Doris have lived in Florida for 12 years and visit New England every summer. They have attended every five-year reunion and have been members of the M.I.T. Club of Fort Lauderdale for some time. They also attended the Florida Festival in Cypress Gardens a few years back.

Frederic D. Merrill of Chatham, N.J., has been suffering from Parkinson's disease. His wife Carmen writes, "Fred may soon be moving to a nursing home, where he will be taken care of. He appreciated receiving a birthday card."

I regret to announce the deaths of the following class members: Rear Admiral **Robert S. Hatcher** of Monterey, Calif., on June 12, 1985; **Oliver L. Barker**, of Falmouth, Maine, in 1986; and **Kenneth G. Garside**, of Blue Hill, Maine, on May 25, 1987.

Kenneth Garside graduated from Harvard, Class of 1927. He received his master's degree from M.I.T. in 1929. He taught at St. Andrews Episcopal School in Boca Raton, Fla., and was a former cranberry grower. He is survived by his wife Barbara, three children, four step-children, and 13 living grandchildren.—**Karnig S. Dinjian**, Secretary, P.O. Box 83, Arlington, MA 02174

30

This month's most extensive communication is from **Sig Linderoth** who, as previously reported, retired about 10 years ago as professor emeritus of mechanical engineering at Duke University. Sig's principal post-retirement activity has been designing hypobaric chambers for both deep sea operations and medical oxygen treatment facilities. Currently, he is writing computer programs "for teaching machine design in this new era of computer-controlled manufacturing." He also repairs and restores old clocks and has just finished building a training sulky for his daughter Marilyn who owns and operates a stable of 20 pure-bred Arabian show horses. Marilyn's husband Pete Sobey spends his working hours flying Boeing 737s for United Airlines and much of his leisure time flying a W.W. II Grumman Widgeon, a twin-engined amphibian that he has modified for use as a fishing boat. As of this writing, the Linderoth's older daughter Janet has completed a doctoral dissertation on teaching computer science to 9th graders, and is due to receive a Ph.D. from Ohio State University in September. She has been hired as an assistant professor at the University of Cincinnati. Doris and Sig are both well, still play golf, and are looking forward to our 60th reunion.

Alfred Luery retired from the Celotex Division of Jim Walter Corp. in 1975. He was a project engineer handling construction of new plant facilities and process facilities. He lives in Largo, Fla., where he is a volunteer driver for meals-on-wheels, as well as a model train buff. He says that he is generally in good health but that since the death of his wife Jeane in May '86, he has had some difficulty "finding enough interesting things to keep mind and body active." Alfred planned to make a trip north in August and to stop on the way to see **Hal Spaans**. A postcard from Norway brings the news that **Morris Shaffer** and his wife enjoyed a Scandinavian holiday last summer. He retired from his position at L.S.U. Medical School about two years ago, but was "kindly given a pleasant office area" to which he goes "with considerable regularity."

We have at hand a notice that **Jim Keely** died of a heart attack on July 18, 1987. Jim was a native of Somerville, Mass. After graduating from M.I.T. he obtained a J.D. degree from George Washington University and thereafter spent his career in the U.S. Patent Office, except for six years of service in the U.S. Army Signal Corps during World War II. In due course he became one of the Chief Examiners comprising the Patent Office Board of Appeals. Since my own patent practice was largely chemical and Jim's area was electrical, we met only sporadically over the years, but I do recall at least one occasion on which I argued an appeal before a board on which he sat. After his retirement he did a bit of consulting work in the patent field, but found that it interfered too much with his other retirement interests. According to my records Jim was the last survivor of the five members of our class who entered the patent office. They were: **Jack Bloom**, **Sam Koren**, **Tom Hickey**, and **Bill Wye**. Jim is survived by his wife Edna of Silver Spring, Md.—**Gordon K. Lister**, Secretary, 294-B Heritage Village, Southbury, CT 06488

31

We send our sincere condolences to the families of **Martin J. Feeney**, 80, and **Leon F. Osinski**. Martin passed away on March 8, 1987. He was a retired Hyde Park school principal. Martin received his master's degree in education from Boston State College in 1932. He served as a first lieutenant for the U.S. Army Air Corp. during World War II, and was a member of the Catholic Alumni Society. His address is 115 Woodard Rd., West Roxbury, Mass. 02132. . . . **Leon Osinski** passed away on October 24, 1986, at which time his home address was 3 Briar Rd., Briarwood, Del. 19803. Nothing else is available concerning his activities. We also have to report the death of **Clifford Akers Harvey**, 79. Cliff left his wife Helen (Sherrill) Harvey, a son, Clifford of Boulder, Colo., a daughter, Helen, four grandchildren, and one great-grandchild. He also left a sister, Barbara (Mrs. Robert Preston Beach of Boston). During his career Cliff was a vice president of Harvey Wells Electronics in Southport, a member of the board of directors, a member of the board of directors of Harrington Memorial Hospital, and a member of

the American Radio League. He was also very active in ham radio.

John Swanton sends the following news. **Ted Morrill** died last September, after a continuing illness, at his home in Amherst, Mass. At his wife Hester's request, I took part in the memorial service at First Congregational Church, Amherst. During undergraduate days, I lived with Ted and his family at his home in West Medford, Mass. An architecture student, Ted spent his career in the insurance field, 45 years with Liberty Mutual Insurance Co. of Boston. We had kept in touch through the years, and Ted and Hester were in frequent attendance at our class reunions. They were at the 55th at Harwichport. Moving to Amherst about six years ago, Ted was active in retired people's activities, vigorously up until the time of his death. Besides his wife, he leaves a son Victor of Chesterfield, Mass.

Claude F. Machen, our class president died October 2 at St. Elizabeth's Hospital in Brighton, Mass., after a brief cardiac illness. He and Jean were on their way to the Orient when the trouble began in California. He was returned to Massachusetts via ambulance plane some days later. We shall all miss Claude. He was active in class and M.I.T. affairs throughout his life. He was our class treasurer for many years, was vice-president and president since February 1987.

Claude was former president and chairman of the board of directors of the Boston Gas Co. He was also a director, trustee, and senior vice-president of Eastern Gas and Fuel Associates, was a former director at Bay Banks, Boston; former director of the Charlestown YMCA; former director of Blue Cross; a trustee of the Chapel Hill-Chauncy Hall School; and was past director of the American Gas Association. He also belonged to a number of civic and social organizations.

On a lighter note, **Dick Ashenden** and his wife Peggy sailed into our cove on the Sheepscot River, Westport Island, Maine, this summer in their motor sailer. We had a nice visit and made at least passing reference to the fact that Dick and I have got to start thinking about our 60th reunion, which **Dave Buchanan** gave us the job of undertaking—1991 is on the way!

Eleanor and **Joe Buswell** made a surprise visit, too brief, as they were touring through the area near our home in Maine. They are giving up their longtime residence near Seattle, Wash., and are at Sun City, Ariz., a delightful retirement community.

Most of you who are interested, have probably heard of our mini-reunion on the Mississippi. Those who haven't, please drop a note to Polly and **Kenneth Germeshausen**. They are in charge of the project.—**Edwin S. Worden,** Secretary, P.O. Box 1241, Mount Dora, FL 32757; **John Swanton,** Assistant Secretary, 27 George St., Newton, MA 02158

32

More about our classmate Dr. **Manley St. Denis**. In a feature article in an Hawaiian newspaper, he was called the "magician of naval technique." In the Bureau of Ships, he played a very important role in the design of aircraft carriers—*Essex* and *Midway*—and the cruisers—*Alaska, Des Moines,* and *Roanoke*—as well as many other ships. His reports and publications over the years exceed 50. He lectured throughout the world partly because of his fluency in over five languages. He was one of the 60 scientists invited for three months at Woods Hole to look into the undersea as an arena of naval warfare. This was where the submarine *Polaris* was conceived. These are just the highlights of a prolific career. He was investigated by the Truman Committee for possible profiteering but was exonerated, and Senator Truman invited him to lunch.

What is **Robert West**, age 84, doing with his days? He is totally absorbed in musical activity. He prepares concerts for his church and their civic functions. His instruments are a plectrum banjo, a classical guitar, and a fine tenor banjo. . . . **Arthur Marshall** continues to make news in Springfield, Mass. He was selected as the local individual who was effective in improving the quality of peoples' lives in the community.

We are sorry to learn that **John Finnerty** 's physical condition has not improved. He thought it wise to tender his resignation as our class agent, a post he so ably held for many years. . . . **Ed McLauchlin** has agreed to carry on as our class agent. . . . **Tom Weston** said he received many comments from our classmates who attended the 60th reunion, all very favorable.

Jim Robson reports that 570 graduated in our 1932 class and that 303 are still among those present.

We learn that **Libero Cappabianca,** 79, died in Haverhill on July 10, 1987. He taught math for 32 years and was chairman of the Machine Department at the Haverhill Trade School. He is survived by his wife Rita, a son, and two grandchildren. . . . We also hear that **Philip Brockington** died in Delray Beach, Fla., on June 5, 1986. We will pass on any obituary information when we receive it.—**Melvin Castleman,** Secretary, 163 Beach Bluff Ave., Swampscott, MA 01907

33 55th Reunion

W.D. "Bill" Harper head of the Harper Research Co., now resides in Hattiesburg, Miss. He was formerly president of the Texas Chiropractic College. He may be reached at Route 4, Box 1080, Hattiesburg, 39401. . . . **Beaumont Whitton** and spouse have a new address: Apt. 319, 5100 Sharon Rd., Charlotte, NC 28210. . . . **Leon Hyzen** and his wife Didi are on a cross-country trip, visiting the family and winding up in New York City, where they will attend a two-day auction of their stamp and postal history collection. They're home base is 2100 South Ola Vista, San Clemente, CA 92672.

Your secretary and wife Martha are also on an extended trip, visiting family and friends along the East Coast, winding up at M.I.T. to combine business with pleasure.

Kenneth A.H. Smith passed away last January 27. Wife Mildred may be contacted at 6080 80th St. N., No. 315, St. Petersburg, FL 33709.—**William B. Klee**, Secretary, P.O. Box 7725, Hilton Head Island, SC 29938

34

To begin on an "up-beat" note, it has become obvious that our class has some hard-core party goers; people who will travel a fair distance if there's any excuse at all. Of course, I'm talking about the 34 members and wives (a good number for this class, isn't it?) who spent three lovely days from September 15th to 18th at Skytop Lodge in the Poconos at a mini-reunion celebrating our 53rd. The "hard-core" part comes to mind when I realized that, as best as I can remember, most of them had been at Williamsburg two years ago. Skytop is a marvelously operated place for an affair of this sort and we were graced with fine weather until the day we had to leave. I won't try to list all the attendees, but fortunately the **Cash Beldens**, the **Dick Sanders**, the **Olmstead Wrights** and the **Ted Kressers** were able to plan their September travels so as to include the party. Unfortunately, **Norm Krim** and his wife Bea had had to drop out; he was recovering from successful intestinal surgery but not yet quite up to a trip like that. There was general agreement that we shouldn't let a good thing die, so **Carl Wilson** will be working on another get-together for next year, with again a general feeling that we could do a lot worse than go back to Skytop. So remember, if you hear noises about something for the coming fall, join in; we had a great time.

Coming back to the harsh facts of life, I have two more losses to report. On February 21, 1987, retired Major General **Robert G. Butler** died, after a long illness. General Butler had graduated from West Point in 1928 and received his S.M. in mechanical engineering with our class. During World War II he was involved with the Manhattan Project and joined the Atomic Energy Commission in 1947. He was promoted to brigadier general in 1954 and received his second star a year later. At the time of his retirement in 1959 he was commanding general of the Ordnance Special Weapons Command at Picatiny Arsenal, N.J.

Following his retirement he taught at the Hopefield Broadview School in Sandwich, Mass., for about 20 years. General Butler is survived by a son, two daughters, 11 grandchildren, and a great-granddaughter.

On March 15, 1987, **Roland D. Eaton** died in Chatham at 84, following a long illness. He had spent eight years, beginning in 1941, doing research for Tel-Col TV in Burbank, Calif. He then worked for 11 years for Weston Instrument Co. in Newark, N.J., leaving in 1960 to return to research on color television for General Electric Co. in Syracuse, N.Y. From 1967 to 1981 he worked as a civilian employee at Fort Monmouth, N.J. On retirement in 1981 he moved to Chatham. Mr. Eaton is survived by his wife Helen, one daughter and four grandchildren.

To both families I would extend sympathy from all the class on their losses.

In the November/December issue I mentioned that I was going train-riding in Switzerland. It was a great trip, with cloudless skies where it counted most—in the Swiss Alps. The scenery was breath-taking (at 12,000 ft. on top of Klein Matterhorn that's almost literally true) and was lucky enough to get some very nice pictures. Having gotten my laundry done after the mini-reunion, I leave on October 23 forAntigua and there on the 29th I will pick up the M.I.T. Quarter Century Club cruise down the east coast of South America to Rio de Janeiro.—**Robert M. Franklin,** Secretary, P.O. Box 1147, (620 Satucket Rd.), Brewster, MA 02631; **George G. Bull,** Assistant Secretary, 4601 N. Park Ave., Chevy Chase, MD 20815

35

This is a good way to start a new year. The following letter comes from **Herbert C. Thomas,** a Course VI man that I remember very well, now living in a 10-room house bordering on Valley Forge Park in Pennsylvania. "This is my first letter to the class of '35 notes. I have felt the urge to write often after reading your news columns. I expect very few of my classmates will remember me, however for the record, here are some highlights. I married in 1936, and we celebrated our 50th wedding anniversary in 1986, with our eight children, their spouses, our 14 grandchildren, and four brothers and sisters. It was quite a gathering! Two of our sons are engineers, one is a doctor and one is a college professor. Three of our daughters are married housewives. One daughter is slightly handicapped and lives at home. I worked for GE for 40 years as an engineer and engineering manager and I retired in June 1976. I had an enjoyable career with assignments with instruments and spacecraft. During World War II I was on active duty for five years, three of them in the Pentagon. After the war I remained active in the Air Force Reserve. I commanded an R&D unit at M.I.T. for several years and retired with the rank of Colonel in 1973. The most enjoyable years of my life have occurred since I retired from GE. I went to work for Elwyn Institutes in Elwyn, Pa., which provide services to severly handicapped people. I started as a two-day a week volunteer which changed quickly to a full-time consultant. My function is to obtain work for and provide technical assistance to the sheltered workshops operated by Elwyn. These now employ about 2,000 mentally retarded and physically handicapped workers. Close to 1,000 of these folks are working on projects resulting from my

efforts. It's a wonderful feeling of accomplishment. Since my retirement from GE I have traveled quite a bit which I enjoy very much. Traveling supports one of my hobbies—photography. Elwyn supports the other hobby—a basement workshop." Many thanks, Herb, if I could receive a letter like that from a '35er each month writing these Notes would be a most enjoyable cinch!

A January 1987 newsclip recently reached me telling of the death of **Lawrence C. Hall** in Manchester, N.H., on January 19th. He was associated with the N.H. Insurance Co. 34 years and retired in 1978 after serving as chairman, president, chief executive officer and director. He served with the U.S. Army Corps of Engineers in World War II. He was Amherst, N.H.'s first water commissioner and was responsible for the installation of the town's water system. He was a former executive vice president and director of the American International Insurance Group of N.Y. and director of Underwriter's Salvage Corp., Chicago. He is survived by his widow, Elizabeth; two sons, five grandchildren, and a sister. . . . **David E. Hollidge**, Course IV, died in his Milton home on March 6, 1987. He was a professional engineer with the Boston Gas Co. for 40 years and spent a year as consultant with Boston Edison when his department was merged with them. He leaves Elizabeth, his widow, a son and daughter. . . . **Edward Gelus**, Course V, died March 28, 1987 in Berkeley, Calif., as reported by his widow, Margaret. . . . **William O. Thompson**, Course XV, died in Evergreen, Colo., on June 3, 1987. . . . Maxon H. King, '25, sent me a clipping telling of the death of **Gerald W. Farr** on September 9, 1987 in Santa Cruz, Calif., where he had worked as a food technologist for 26 years. Survivors include Helen, his wife of 53 years, two sons and two daughters.—**Allan Q. Mowatt**, Secretary, P.O. Box 524, Waltham, MA 02254

36

Let's raise our glasses and give a cheer for the life of **Laddie Reday**—exuberant, jolly Laddie, whose bent for unusual activities appealed to the adventurer in all of us. Readers of these Notes over the years—and that includes about 98 percent of the class—remember his jaunts to mountain tops in Russia, Greece, Nepal, Japan, you name it, and I chuckle again at his flight to the North Pole hoping to land and ski around that spot of ice.

Laddie died August 25, after collapsing in a coma August 14 of a sudden circulation problem which deprived his brain of oxygen. His wife Peg, speaking of his 30 years of free-lance writing in numerous publications, said it was his deepest love, and "he always said that when he went, he wanted to fall off a mountain. We're saying he fell off his mountain."

Laddie's expeditioning started after graduation with a survey in the South Seas for the New York Museum of Natural History. In World War II he helped chart the New Guinea coast while a captain in the Army and took wounded men off the beaches under fire. So the unusual was usual for Laddie. God bless him and the uplift he gave to the many who knew him well.

Also deceased, on February 14 of cancer, is **R. Marshall Christensen**, who came to Course IV after graduation from Notre Dame. Marshall had a long career in architecture and design. Beginning with Gulf Oil in Venezuela designing houses, bridges and roads; on to oil installations and warehouses in India and Ceylon, then landing gear for Fairchild Aircraft during the war. In Greenwich, Conn., thereafter, he left his mark with a variety of public and private structures—hospitals, banks, schools, condominia, a hotel and a convent. Hats off for another life well spent.

Charlie Holman writes from 3038 Heatherglen Rd., Montgomery, TX 77356, whence he moved from Stamford in July. He and Lucy built a new home on Lake Conroe, about 60 miles NW of Houston. Shortly after our 50th reunion he won the World Championships for skeet shooting in the veteran .410 and high-over-all classes, and in 1987 won similar honors in four individual state competitions and the group of six southwestern states. He is Captain of the Veterans All America Skeet Team, and keeps in shape with two-mile daily runs.

My mention last September of 14 men in an eight-oared shell prompted an addition and a disclaimer, and I expect there will be more of the latter. **John Myers** was one of the eight I overlooked, and he recounts our winning the Richards Cup race with one oar out of commission and other handicaps. Let's hear from the other six oarsmen. **Bob Lutz** was *not* in the boat, and his account of why not will interest all past, present and would-be flyers: "As I recall, the crews were expected to work out during the vacation time. Instead, I took off with a fraternity brother on a flying excursion to Washington and back. He had chartered a plane of the early Piper Cub type to build up his time to keep his license. I could read maps pretty good so with high hopes and no radio we took off for four days of aerial adventure. We landed at Newark and at a U.S. Army field in Washington, but were shooed off in the gathering darkness and managed a night landing (without lights, of course) on Ludington Field. On the trip back to Boston, making a bladder relief stop in Langhorn, Pa.; we made a bad landing, washingout our landing gear and prop. Next day I supervised the landing gear repair while Charley went to New York to get a new propeller. Then on to Boston a day late and more than several dollars short. But we were all in one piece, which considering the odds is nothing short of a miracle. When I reported in for crew the next day I found that I had been displaced in the boat (by **Slim Beckwith** I think) and was not regarded favorably by the coaching staff. I gradually found other interests, one of which studied at Wheelock College."

Bob continues: "Have you seen the TV commercial featuring **Marvine Gorham**? He has an old classic T-Bird that he has driven some 470,000 miles with the help of some magic compound oil. He doesn't seem to have changed a whit—a tribute to good thinking or good drinking—take your choice."

Obviously, Phoebe and I are back home from our camping trip in Europe, and the Henley regatta and Wimbledon. Unfortunately, in the tens of thousands of tennis fans we did not cross paths with Laddie and Peg, on their way back from a trek (their last) in Tuscany as reported by close friend Pat in the October notes.

Just in time for these notes, another tribute to **Hib Summersgill** for his outstanding work for the Institute and the Alumni Association. He has been awarded posthumously the Harold Lobdell Distinguished Service Award, to be announced at the National Alumni Conference and conveyed to his widow Jean.—**Frank Phillips**, Secretary, 901 Los Lovatos, Santa Fe, NM 87501 (505) 988-2745; **James Patterson**, Assistant Secretary, 170 Broadway, Pleasantville, NY 10570 (914) 769-4171

37

William Bakarian, 3750 Galt Ocean Dr., Fort Lauderdale, FL 33308, is still active as a self-employed consultant in energy and minerals. He "swims and lives on the beach when not working." His travels included Europe/England, Japan and Southeast Asia on work projects. . . . **Joseph Haywood**, 124 West 36th St., Erie, PA 16508, retired January, 1976, as a Design Engineer for AM Sterilizer Co., Erie, Pa., and is semi-retired working as an adjunct professor, Gannon University, Erie, Pa. Travels sometimes.

Dick Young, our reunion chairman, received the following letters: **Obera Lee Alder**, 2302 Country Club Parkway, Garland, TX 75041 wrote about her reunion experience. "I shall be forever grateful to the Class of '37 for having me as their guest. Incidentally, I have nothing but the highest praise for the Hyatt in Cambridge as well as Mass. General. When I was taken to the hospital, the funniest thing was being run down the hallway of the Hyatt Hotel at full speed on the stretcher and having to descend from the 8th floor to the main lobby in one of the glass elevators, lit up like a Christmas tree. It's amazing how many people were in the lobby at that early hour. At least, the oxygen mask covered my face. I was completely stabilized but the excellent paramedics were taking no chances. I have just had a report from my doctor here that all tests were negative, no heart attack, and there is nothing wrong except too much partying! (I who never go out alone at night.) It was the same as I was told at Mass. General. So I'll be around for a few more reunions!" Dr. **Ray H. McFee**, 5163 Belmez, Laguna Hills, CA 92653 wrote that the reunion was a memorable experience for himself and his daughter Judi. "Judi really enjoyed meeting my old friends and their wives." . . . **Leo B. Moore**, 6 Winthrop Rd., Lexington, MA 02174 wrote that he was unable to attend the reunion due to health problems and sent his wishes for a memorable reunion. "I won't bore you a litany of my problems that started last September, two weeks before I was to be honored at a huge affair in Philadelphia. I called that off and have turned down several great opportunities, like going to Singapore on an interesting assignment. So, the past six months have not been very happy for me, particularly when the medical people have not yet found any means of improvement for me. This, in spite of all the latest technique and knowledge, has been depressing."

From **John Pitkin**'s wife Marion, 29732 Ellendale Dr., Laguna Niquel, CA 92677: "John would truly love to come back for the 50th and we have seriously considered it for months. John has Parkinson's disease and isn't sure just how well he could make the trip. We do our traveling by car, and can stop when he tires. He is able to get around all right, although slow, but writing and talking are getting very difficult. He will be thinking of you on that weekend and sends his best regards to all of you." . . . **L.P. Reitz, Jr.**, 700 Mexico Place, Palos Verdes Estates, CA 90274 wrote, "I don't think I have ever thanked you for arranging the perfect reunion. It was a highlight of my life. Let's do it again at the 55th!"

Martha Q. Knapp, 250 Mansfield Ave., Darien, CT 06820 wrote, "I regret to inform you of the death of my husband **George Owen Knapp**. He died May 7, 1987, of lung cancer. After graduating from M.I.T. he was with Union Carbide for over 30 years. He served in the U.S. Navy during World War II, seeing action in both the Atlantic and Pacific, and retired with the rank of Commander. He leaves four children and three grandchildren." . . . It is with regret that I report the death of **Gardner A. Murray**, 24 Knoll Rd., Woodbury, CT 06798 who died June 25, 1985. Mr. Murray a retired architect for Anaconda American Brass was a member of the board of directors of the Pearl Street Community Center and the Mattatuck Museum. He was the husband of Virginia Murray. He was an avid gardner, grape grower, wine maker and tennis player and was interested in Third World music. He was former member of the Woodbury High School building committee. Besides his wife, he leaves three daughters, three sons, and seven grandchildren. Memorial contributions may be made to the Connecticut Junior Republic in Litchfield.

I wish to supplement our brief October report of the passing of **Eric D. Swenson**, 20 Lynn Ct., Darien, CT 06820 who died February 10, 1987. A resident of Darien for 32 years, Mr. Swenson retired in 1978 from a 33-year career with the American Bureau of Shipping of New York and other locations. He was considered an expert in the design, construction and maintenance of specialized ocean-going vessels. He was active as a scout leader and was a member of the Masonic Order. He is survived by his wife, Ruth, a daughter and a son, Ronald. . . . I regret to report the death of

Peter P. Chunko, of 5 Barberry Rd., West Islip, RI 11795 late Easter evening April 19th. Peter was born October 10, 1897. He is survived by his wife.—**Lester M. Klashman**, Secretary, 289 Elm St., Apt. 71, Medford, MA 02155

38 50th Reunion

Ed Hadley, our class reunion gift chairman, thought it would be interesting to find out how many of us have M.I.T. alumni relatives, especially since he thinks he holds the record with an '05 father and '65 and '72 sons. Offhand, we can add **Norm Leventhal**'s brother Bob in '36, my own son Bob (he's both '65 and '67), my former daughter-in-law Lynn Bruneau in '68, **Harold Strauss**'s son Ed in '65, **Dick Muther**'s uncle Walter, and **Dave Wright**'s brother-in-law Pen Brooks. Please let me know if you have any additions.

I have several belated deaths to report. **John Sawyer** passed away last April in Forsyth, Ga. John is survived by his widow Helen.

Clint Tylee died last March in St. Albans, N.Y. Clint is survived by his wife Phyl. He had been chairman of the mathematics department at Bellows Free Academy until his retirement in 1974. He and Phyl have owned Tylee's Yachting Service, a marina in St. Alban's Bay, since 1960.—**Armand L. Bruneau, Jr.**, Secretary, 663 Riverview Drive, Chatham, MA 02633

39

Classmates are already enthusiastic about our 50th reunion at Chatham Bars Inn on the Cape, 4-7 June 1989.

Evan Pancake received his Class Day beer stein in 1939, and encouraged it to perform useful service for the next 48 years. Now Evan is volunteering to donate it at the reunion as a prize for an event to be designated by **Doc Wingard**'s committee. Evan and Dee continue to vacation in New Zealand, Australia, Hawaii, and the Caribbean. Now at home in Charlottesville, Va., they volunteer recording for the blind and serve on the board of directors of the Creative Glass Center of America which gives fellowships to glass artists.

Morrie Nicholson is preparing for the reunion and writes from Minnesota. During his career Morrie pioneered instructional television (he broadcast engineering classes to major corporations). For ASM International he organized a conference on electronic packaging materials and processes and corrosion in microelectronics. 250 attended from the U.S. and Canada. Morrie and Norma cruised on the Delta Queen out of St. Louis and became certified calliope players. For 36 years in Boy Scouting they are the first husband-wife team to receive its prestigious Silver Beaver Award (Scouting's highest award for volunteers). Morrie plans to write all '39 Theta Delts about reunion. He recalls John Alexander, Bill Brewster, Theron Curtis, and Bob Saunders at our 45th.

Arlene and **Irwin Weiss** plan to attend the 50th. His career with General Motors may have conditioned Irwin and Arlene to travel. In the last three years they visited in the Phillipines, Singapore, Thailand, China, Hong Kong, South Korea, Japan, England, Amsterdam, Leningrad, the Nordic countries, Hawaii, Australia, New Zealand, and Fiji. They especially enjoyed a visit with Gay and **Ben Badenoch** in California. When not traveling, Irwin and Norma may be at home in Birmingham, Mich.

Lucille and **Oz Stewart** enjoyed a three-week tour of 14 cities in China. A highlight was a 3-day visit with Julie and **Charles Wang** in Shanghai where Charles is active with the Shanghai Federation of Industries program to develop new trade with the U.S. and Canada.

We are saddened by news of the death, on 4 March 1987, of **Elliott C. Fisher**. Elliott's career in banking included 20 years in New Bedford, Mass., and 21 years in Naples, Fla.

On the brighter side, enthusiasm for our 50th indicates our class may be about to set another Institute attendance record. To make that happen, ideas must be examined and satisfying work needs doing on behalf of Institute associations we all treasure. If you just happen to know idea persons or work persons, why not ask them to call **Bill Wingard**, reunion chairman, (301) 358-2210.—**Hal Seykota**, Secretary, 1701 Weatherswood Dr., NW, Gig Harbor, WA 98335

40

Recently, I learned that **John Vanderpoel** has been engaged in an unusual activity. As a result of a meeting about ten years ago with a young polio victim, John became interested in building wheelchairs, particularly for those who participated in wheel chair marathons. He has three employees, all in wheel chairs, who made over 200 chairs last year. These are light weight units, and each one is made to meet the specific requirements of the user. Besides marathon chairs, the company also makes chairs for smooth floor use. John does the design work, and most of the machining, and the men in the wheel chairs do all the rest!

Alvin Guttag called recently to pass on news about himself, and others. After working part-time in recent years, Al finally retired in July, 1987. His stamp collection occupies him, but his primary interest is in running—a sport in which he has been participating for almost 50 years. He runs at least seven miles daily, and holds records in the three-mile and ten-kilometer races in the 65-69 year old age group.

Al reported that **Garret Wright** has undergone additional surgery, but is doing well now. Al has also heard from fellow stamp collector **Fred Hammesfahr**.

Unfortunately, I must report the passing of two class members. **Walter H. "Hap" Farrell** died July 31, 1987, in South Orleans, Mass., where he had just moved in December, 1986. The treasurer's office at M.I.T. is receiving contributions in his memory. . . . **Massimo Baer** passed away February 28, 1987, in Longmeadow, Mass. He had retired from Monsanto, Co., where he held the title of senior fellow, granted by Monsanto in recognition of superior achievement. The Springfield, Mass., *Sunday Republican* wrote, "Baer held more than 120 patents leading to the development of many significant plastics. He was considered one of the outstanding experts in his field, in the United States and abroad."

Treasurer **Edgar Bernard** reports that he has received a number of address changes from M.I.T. He is trying to remain current on all class members, but in case you have not received your notice of class dues from him, please let him know your new location. Than you will be sure to receive direct information on the 50th reunion.

The *Wellesley* (Mass.) *Townsman* recently mentioned " . . . dapper **Edward Kingsbury**, also known in these parts as 'Mr. Slideshow.'' Ted and his wife Edith have devoted countless hours to Wellesley's historical slideshow, the film series at the library and the local chapter of the American Association of Retired Persons. Ted is well known and respected in this office. Few work harder in this town than Ted Kingsbury to aid senior causes."—**Richard E. Gladstone**, Secretary, 1208 Greendale Ave., Needham, MA 02192, (617) 449-2421

41

David S. Saxon has been named a director of the Greater Boston Chamber of Commerce. . . . From a clipping of the *West Springfield Record* we learn that **Richard W. Tindall** died in July, 1987, in Oneida, N.Y. For 17 years he was a chemical engineer for the Camden, N.Y. Wire Co. He leaves his former wife Priscilla VanLoan, two sons, a daughter, and two grandchildren.

Dr. **Adam J. Miller** died September 15, 1986, after a valiant battle against advanced lung cancer. His daughter Alison J. Miller Domecq survives him. . . . **Donald H. Howard** died April 20, 1986. . . . **John M. Wheeler** died August 5, 1987, of cancer of the pancreas.

John M. Porter retired from the National Weather Service in 1986. He also has an Air Force retirement, with over 20 years of active service. John has a masters degree in meteorology (M.I.T. '41), and a B.S. degree in engineering from the University of Utah. John and his wife live in Silver Spring, Md., and have a second home at Lake Sunapee, N.H. Vera and John have 2 children and 4 grandchildren; the oldest 17 and the youngest 1 month old. They live close by in Maryland so we see a lot of them. In the summer in N.H. John plays tennis and golf and has traveled several times around the world since his retirement.

Frank J. Ball has been retired from Monsanto for about 5 years. He still keeps very busy with various projects plus some consulting work on environmental pollution studies and corrections. He spends the summer in New York state at a summer place on a small lake, and winters at Wilbraham, Mass., or in Florida.—**Joseph E. Dietzgen**, Secretary, Box 790, Cotuit, MA 02635

42

Class news is nil. Have heard from **Jim Engel**, **Jim Stern**, **Welville Nowak**, **Gerry Schucter**, and **Ed Thode**. So what do they all have in common? They are members of the distinguished (?) New Rochelle High School Class of 1938 and we are busily planning our 50th reunion scheduled for June 1988.

Sadly, we do have five obits. Both **Alan Katzenstein** and **Charlie Smith** sent the news of **Shep Tyree**'s death. Shep got his S.B. and Ph.D. in Course V; taught for professor L.F. Hamilton, continued teaching chemistry for 20 years at Chapel Hill, following which he was professor of chemistry at the College of William and Mary.

Bob Higdon died in Santa Rosa, Calif. He had retired there in 1983 after a career which included teaching electrical engineering at Penn State, some years in industry and then a stint as vice-president and technical director for the electronics industry at Chase Manhattan Bank in New York. Among other honors, Bob was a life member of IEEE.

Al Copeland got his S.B. in Course XV, graduated from Annapolis in 1944, spent three years in the U.S. Navy, completed a law degree at Harvard Law School. He spent several years working for government agencies and from 1954 until his retirement was with Lehman Brothers and its successor firms.

A clipping from the *Washington* (D.C.) *Post* tells that **Bill Devine** died at Gaithersburg, Va. He was in Course X and also attended the U.S. Army Command and Staff College and the Federal Executive Institute. Bill served in World War II as an engineer officer in North Africa and in Italy, and was a Colonel in the U.S. Army Reserve. He worked for the Atomic Energy Commission in Springfield, Mass., and in Richland, Wash. before returning to Washington, D.C. as the agency's director of production in 1971. He retired in 1974.

Finally, **Bruce Oakley**, also Course X, died in Elkton, Md. He was, for many years research and development project manager for Container Corp. of America in Oaks, Pa., and lived in Kennett Square. Our sincere sympathy to their wives and families.

Enough already? So send me some happier class news!—**Ken Rosett**, Secretary, 191 Albemarle Rd., White Plains, NY 10605

43

I'm gratified this month to have several letters and news clippings, but no obits. **George W.**

"Bill" Potts writes that he has left Connecticut to reside in Leesburg, Fla. Golfing three times a week in the tropical climate brings back memories of the years he spent in Havana, Rio, Manila, and other centers of lotus-eating. Bill continues to put in a few hours as officer and director of a small reinsurance company. In addition, he still finds time for his old hobbies of sculpting, astronomy, ham radio, and photography. Like other classmates living in Florida, Bill is hospitable. Just show up in Leesburg with your golf clubs and swim suit.

A brief note from **Gil Monet** reports his ongoing love affair with art, music, opera, and ballet. His wife Marion plays the harp and the cello, giving public performances with a number of groups in the Wilmington, Del., area.

Gil also sent along some clippings about **Virgilio Barco Vargas**, the new president of Colombia. The news is that Virgilio is striving against many obstacles to bring democracy and order to his nation. His greatest opponents are the drug barons, whose bribery and intimidation reach to the highest levels of government. Under the circumstances, we probably won't see him at the 45th reunion in June.

Hans Walz reports continued activity by the reunion committee, as well as news about himself. Hans has retired after a colorful 40-year career as a distributor of dyestuffs to the textile, leather, and affiliated industries. He and Vicky will keep their home in Wellesley and summer place in New Hampshire. Three daughters also live in New England, so family ties will be maintained. Think reunion.—**Bob Rorschach**, Secretary, 2544 S. Norfolk, Tulsa, OK 74114

44

A letter from Mrs. E. Jane Fuerman brought the sad news of the passing of **Arthur Fuerman** (Course II) on June 29, 1987, in Pottstown, Pa. Art worked for Bursich Associates, Inc., Engineers of Pottstown. He is survived by his wife, a daughter, Lauren, who is an open heart R.N. specialist, and a son, Richard, a freshman at Wilkes College. Our deepest sympathy goes to his family.

The reunion committee is continuing the work for the 45th. By the time you read these notes, you should have received preliminary information regarding time, hotel, and travel arrangements for Bermuda. June 1989 is only some 18 months away, so start thinking seriously about attending!

Class president **Norm Sebell** and your reunion committee send best wishes for the holiday season and a very happy new year to all our classmates and their families.—**Co-secretaries: Andy Corry**, Box 310, W. Hyannisport, MA 02672; **Lou Demarkles**, 53 Maugus Hill Rd., Wellesley, MA 02181

45

Retirement is great but I sure miss the secretarial services of Allendale that I took for granted those 38 years!

A belated Happy New Year to you all; how about that resolution to keep your Secretary up to date on your latest activities?

Prexy Chris Boland's wife, Jean, was here in New Castle yesterday enroute to help their youngest plan her June wedding while Chris was in London on business. . . . Fran and I ran into **Jake Freiberger** at the Albuquerque Airport in early September, as we returned from a two-week sojourn in Colorado and New Mexico. Jake was enroute to Dallas from his Durango, Colo., retreat. Considering his health problems, Jake looked great. In fact, we made tentative plans to help him and **Jim Brayton** move his Hinckley down the coast from Maine this spring. Speaking of sailing, Fran and I did sail with Lou and **Pete Hickey** this past summer aboard our *Dulcinea*. All is well with the Hickeys; all they could do is rave about their 40th anniversary trip to Alaska last June.

Sherry Ing, who continues as a M.I.T. Corporate Development Committee member, is now getting his kicks out of running in a hands on fashion Aloha Airplanes in Honolulu; our resources indicate that Sherry is having a ball. . . . **George Berman**, chairman of Unitrode Corp., and **Alan Gruber**, chairman and CEO of Orion Capital Corp., were given M.I.T. Corporate Leadership Awards at the Institute last spring. . . . **Dick Battin**, associate department head of NASA Programs at the Institute, continues to reap AIAA Awards—1987's Pendray Aerospace Literature Award at the 25th Aerospace Sciences meeting.

Emmett Day retired as professor of mechanical engineering at the University of Washington in June 1985 and currently travels for fun! In the interim, he has taught at the University of Washington's "Architecture in Rome" course as well as participating in technical meetings in Beijing, China, in late 1985. . . . **Robert C. Miller**, who retired from Grumman Aerospace in August 1986, is not only consulting but is chairman, anti-air warfare committee, National Security Industrial



Harry Mergler

Associations. . . . In March 1986, **Harry W. Mergler**, Leonard Case Professor of Electrical Engineering at Case Western University in Cleveland, was elected for a two-year term as director of IEEE; he will represent Division X which covers systems and controls. Harry has been at Case for 30 years; his engineering research centers on the use of digital computers in various loop control systems, industrial robots and air traffic control systems.

At this stage of our lives, we all too often must report the death of classmates and friends. **George B. Hetrick, Jr.** died of cancer after a long illness in Lancaster, Pa., his old hometown, on April 28, 1987. At the time of his death G.B. was vice-president of finance of Des Corp. and a licensed real estate broker. Prior to getting into real estate in 1971, Hetrick worked for Armstrong Contracting and Supply, a division of Armstrong Corp. George is survived by wife Norma and a son, G. Blaine, III, a 1985 graduate of Boston College. G.B. was a roomate freshman year at the old Phi Sigma Kappa house on Commonwealth Ave.—a great guy!

Wilbur F. Young, III, chairman and CEO of W.F. Young, Inc., in Springfield, Mass., died while aboard his *Petrel* at the starting line of a race off Groton Long Point, Conn., on July 18. W.F. Young Inc. manufactures Absorbine, a veterinary liniment and Absorbine Junior, a liniment for humans. Young left the Institute for U.S. Army Air Corp. duty early on and later graduated from Yale University. . . . Another non-graduate, **Harald J. Coughlin**, died last spring at Dartmouth, Hitchcock Medical Center in Hanover, N.H. In 1971, Coughlin formed Cough, Inc., which operates several McDonald's in New Hampshire and Vermont.

Our class was well represented at Pops last June. In the normal and usual fashion, Tech Night at Pops was preceeded by cocktails and dinner at Zachary's in the Colonnade with the following attendees: Jan and **Charlie Patterson**, **Bill Meade**, Nancy and **Charlie Hart**, Dee and **Frank Gallagher**, Anne and **Bob Maglathlin**, **Mary Trageser**, **George Berman**, Carolyn and **Jim**

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Pickle, Janice and **Dave Flood**, Louise and **Tom McNamara**, plus Fran and myself. **Frank Gallagher** continues with his construction business, but only after 10:00 a.m., as some of his offsprings are picking up the strings. **Charlie Hart** will have retired from Raytheon by the time you read these notes; while **Dave Flood** has no retirement thoughts, **Jim Pickle** continues to teach at Milton Academy, and George Berman serves as Chairman at Unitrode. The balance are in varying degrees of retirement and/or adolescence. Cheerio!—**Clinton H. Springer**, Secretary, P.O. Box 228, New Castle, NH 03854

46

I was about to close up shop on this edition when a pretty postcard from **Larry Body** arrived from Chester, England, sending regards. He and Ginnie had a grand time in mid/late September putting 600 miles on a rented *Fiesta* "and terrorizing the natives." This sparked me into another trip through the bio book. . . . I don't think I've mentioned **Harry Augenblick** who sprung from Course VI immediately into ITT. In 1950 he founded Microlab and set it up in North Jersey. Now president, he lives in Floram Park, a step away from my wife's best old buddy. He has two daughters and a son, Harry Jr. Another remarkable story from **Mel Zisfein**, a Course XVIer who pulled both his B.S. and M.S., formally in '48. At any rate, he went on to ply his trade in the aerospace industry, finally to be selected by the Smithsonian as deputy director of their Air and Space Museum in 1971. He was rewarded with the Exceptional Service Medal and a Citation. Since then Mel has become the director of the Department of Defense National Science Center which sounds fabulous. He and wife Alice have six kids and five grandchildren. They're enjoying the ambience of life in Augusta, Ga.

Here's **Ed Bacon**, a September VIer who got his M.S. two years later. He's hopped around a little, starting with GE, Schenectady, and working his way up through RCA, Camden, and assorted places in D.C. (Beltway Bandits??) ending up trying to create order out of chaos in the U.S. Postal Service. He hopes to afford retirement sooner than later. Ed and wife Martha, of 40 years, like biking, sailing, gardening, and keeping in touch with three kids, all college graduates! You've done good, Ed. . . . Another V-12 XVIer I've somehow overlooked is **Guy Wooden**, a D.C. lad who made a career in naval aviation both as pilot and engineer. Been through all kinds of interesting "billets," finally retiring in 1967 as a Commander. Guy did four years managing GE's jet engine programs, and wound up in financial services in Phoenix and living in Tempe with wife Mary of 36 years. Blessed with eight children, most of them (or all?) with degrees—two attorneys and one M.D. Ole!! . . . Another September son, **Dick Ballman** picked up his X letters and after a two-year stint with Firestone hired on with Monsanto where he stayed for 34 years, ending up in Pensacola as head of their fundamental research and with a dosier that includes 75 papers and ten patents in polymer rheology. Small wonder he's listed in *American Men and Women of Science*! Dick has been retired these past five years. He and wife Jane, a Maine Univ./Smith/Mt. Holyoke grad, have three daughters and a son. They're still paying college bills. Remarkably, Guy goes birding in places like Attu and St. Lawrence Islands and has written a paper on molluscs of Northern Gulf of Mexico. Oh yes, they're living in Gulf Breeze, Fla., in case you'd like to check on them.

Looking finally at **Cliff Woods**, a V-12 Course X June bug, followed with a '48 XV B.S. Cliff got into banking early on with Citibank, presumably in Greenwich, Conn. He also presumably retired this past spring. He's tried to convince wife Mary to retire from working with a Greenwich architectural firm doing builder-developer housing for the elderly. They have two daughters and two sons all doing interesting things which they try their best to keep track of. Speaking of which, Bettie and I drove her '78 Colt back to Columbus, Ohio, in mid September to turn it over to son Aaron as a 28th birthday gift. We had a grand time. Hope you all had a grand Christmas holiday!—**Jim Ray**, 2520 S. Ivanhoe Pl., Denver, CO 80222

48 40th Reunion

Plans for our 40th reunion October 7-9, 1988 are being made. We have reserved rooms at the Marriott Hotel, which was recently built across the street from the old F & T Delicatessen on Main Street in Kendall Square. A welcome party on Friday night is intended to provide a relaxed atmosphere to renew old friendships. There will be one or two seminar programs on campus during the weekend. Tours of M.I.T. and Boston will also be scheduled. An elegant dinner dance is planned for Saturday. As indicated in earlier reports, provision will be made for classmates who want to limit their expenses by providing their own accommodations and by attending only seminars and receptions. In response to several requests, the reunion committee will plan and offer, with separate reservations, a foliage tour in New England.

Denny McNear conducted a meeting of the steering committee working to solicit our 40th reunion Gift. He met with **Peter Saint Germain, George Clifford, Sonny Monosson, Norm Kreisman, Milton Slade**, and yours truly. Denny then called **Rudge Allen, Ken Brock, Dave Cist, Dan Fink, George Keller, Jack Page, Vince Vappi, Bill Weisz, Bob Wofsey**, and **Bill Zimmerman** to fill them in on the progress of the solicitation. We have until June 30, 1988, to make our current gift and our pledges for the next five years. I don't have a complete list of all our classmates who are assisting with the solicitation, but our class is fortunate that we are receiving support by donors and solicitors.

Joseph Mallen has retired as president of Boeing Vertol Co. in Philadelphia. . . . **Roland Nagy** has completed 25 years with Foster Wheeler in New Jersey. He started as senior process engineer and moved into more senior positions in commercial development. He was elected divisional vice-president of Foster Wheeler USA in 1983 and president of Foster Wheeler Synfuels Corp. in 1984. Roland and his wife Catherine reside in Caldwell, N.J. They have three children and Roland finds time for golf, photography, music, and his home workshop. . . . **Bill Zimmerman** and three associates purchased the Huntington Sheraton Hotel in Pasadena. The Huntington, built in 1907, was the last of the great resort hotels. In earlier years, guests came for the season and brought their servants who occupied adjacent rooms. In recent years, the small servant rooms became difficult to rent, and the building required structural reinforcement to meet the current code for earthquake resistance. Pasadena required a voter referendum to allow the owners to rebuild the hotel, and Bill became a politician seeking public support. The referendum has been approved by the voters, and plans are under way for reconstruction. Bill sold one his companies to Electronic Data Systems. He also sold the bakery that he had acquired in 1985.

Our class, M.I.T., his family, and his friends have lost a wonderful friend and supporter due to the death of **Bob Bliss** last August. Bob was elected president of the class at our 10th reunion in the Berkshires. He served for five years in that office and was an active member of many reunion committees. His thoughtful proposals were a contribution to every committee he served on, and you could always count on Bob to implement some portion of every class activity. I have fond memories of tying Tech dinghies to the top of Bob's and my cars and driving to the Cape with them so that classmates could enjoy a sail during our 15th reunion at the Belmont. Bob served M.I.T. as an active volunteer and for nine years as a full-time development officer. He was a cofounder of the Route 128 M.I.T. Club and served as president of the M.I.T. Club of Boston. Always active with the Alumni Fund, he was chairman of M.I.T.'s Second Century Fund campaign.

Bob worked for the United Shoe machinery division in Beverly, where he was director of mechanical laboratories and director of research planning. In 1985, he graduated from Harvard's Graduate School of Education and began teaching at Sunapee, N.H., High School, where he taught mathematics until the time of his death.

In World War II, Bob was a platoon leader in the infantry in Europe. He received the Purple Heart after being wounded in action. He also received the Bronze Star and the French Croix de Guerre. Bob married Rose "Nan" Head five years ago. They were able to share numerous trips, many creative community projects in Sunapee, and the pleasures of grown children and ten grandchildren. Last summer Bob and Nan visited Ireland and Great Britain for five weeks.

The class officers have made a contribution to our M.I.T. Scholarship fund in memory of Bob and our other departed classmates. On behalf of our class, I offer our sympathy to Nan and her family.—**Marty Billett,** Secretary, 16 Greenwood Ave., Barrington, RI 02806

49

Recently, I learned that **Earl W. Eames, Jr.** (see photo, facing page) was back in the states as newly-appointed manager of the Minneapolis/St. Paul Center for Save the Children Federation (STCF). Now, in a handwritten note, Earl rounds out the picture a bit by explaining that STCF is a large international community development agency with a craft shop and office at River Place in Minneapolis. He urges us to visit if we are in the area. The big news, however, is: "We now have one grandchild, Earl IV, two daughters-in-law, a daughter who is a professor at Haverford (Pa.) College, and one son still a bachelor."

Thirty-four years ago (1953), **Bruce Campbell** established a firm to provide services in the areas of traffic engineering, transportation planning, and highway design. He called it Bruce Campbell & Associates. In 1971, he dissolved the firm when he was appointed commissioner of the Massachusetts Department of Public Works. But now, according to his hometown newspaper, the *Marblehead* (Mass.) *Reporter & Messenger*, he has re-established the business.

Dr. **Richard K. Pitler** of Gibsonia, Pa., was installed as vice-president and trustee of the American Society of Metals (ASM) International during the Society's Annual Meeting last October. After earning M.S. and Ph.D. degrees in metallurgy from Rensselaer Polytechnic Institute, Dick joined Allegheny Ludlum Steel at Watervliet, N.Y., in 1950, where he served for 36 years with the company. Dick is a fellow of ASM, a member of the society's Alloy Phase Diagram Appropriations Committee, a past member of the nominating and finance committees, and has served on the board of trustees since 1984.

If I want to observe the maximum diameter of the pupil in a cat's eye, I look at it with a bright light. Right? "Wrong!" thunders **Peter K. Stein** of Stein Engineering Services in Phoenix, Ariz. "Any high school dropout knows that, according to the Heisenberg Uncertainty Principal, most cats will look the other way." To remedy such misconceptions, Peter is sponsoring a series of short courses in measurement technology to be given in Phoenix March 7-18, 1988. Peter has been making these presentations all over the world, and the list of his patrons looks like a who's who of the educational, governmental, and industrial world.

The news has been distressing this month because I must report the deaths of four of our classmates. My heartfelt sympathy, as well as that from the class, goes out to the families of these men. **Murray Glauberman** died from lung cancer

at the age of 59 on August 16, 1987, in Akron, Ohio. I learned about this by chance from Harold Shufro, proprietor of a local hardware store. Harold, a wartime buddy and lifelong friend of Murray's, knew I had gone to Tech and thought maybe I knew Murray. He thought correctly. I called Murray's wife Lenore to extend condolences. She said Murray was president of Malco Products at the time of his death and that he was looking forward to becoming chairman of the board so that his sons, Stuart and Jay, could become president and vice-president respectively. Murray is also survived by a daughter, Carol, who recently presented him with a granddaughter.

Warren Reid, '48, called to tell me of the death, on September 6, 1987, of **Robert K. Breese** of Calabasas, Calif. Bob, Warren, and I had been friends in school when we lived in Senior House. According to Bob's wife Peggy, Bob never recovered from injuries sustained in a 1975 automobile accident. Bob received an M.B.A. from Harvard following which he was associated during his career (not necessarily in chronological order) with Westinghouse Air Arm Division in Baltimore, a Chrysler dealership in Baltimore which he owned, Hughes Aircraft Co., and the CIA. In addition to his wife, Bob is survived by a daughter, Tina, and three sons, Miller, Roggie, and Donald.

An obituary in the March 15, 1987, issue of the *Claremont* (N.H.) *Eagle-Times* reports the death on March 13 of **Harrison N. Thibault**. Harrison graduated from Tech as a mechanical engineer. For 33 years, he lived in Hopedale, N.H., where he worked as a mechanical research engineer for the Draper Division of Rockwell International. During his years in Hopedale, Harrison was a founder and on the board of directors of the Blackstone Regional Trade School, a councilman on the board of the Hopedale Boy Scout Troop, and past-president of the country club. In addition to his wife Anna, Harrison is survived by a daughter, two sons, two grandchildren, a brother, stepbrother, stepsister, and several nieces and nephews.

The July 20, 1987, issue of the *Washington Post* reports the death on July 19 of **Leonard E. Meyer**, an architect with the Veterans' Administration (VA). He died at home in Washington, D.C., of cancer at age 66. Between 1955 and 1982, when he joined the VA, Leonard worked with a number of architectural firms in the Washington area on projects such as the restoration of the Old Executive Office Building. Just before joining the VA, he was a principal associate with Nicholas Satterlee and Associates. At Tech, Leonard earned a degree in architecture and later studied under famed architect Frank Lloyd Wright. Survivors include his wife, Mary Brilla Meyer, and a son, Edward, both of Washington. In addition he leaves a brother Karl E., and sister, Susan Meyer, both of New York City.—**Fletcher Eaton**, Secretary, 42 Perry Dr., Needham, MA 02192

51

Active as a lecturer in mathematics, controls, and thermodynamics at Northeastern University and Wentworth Institute, in addition to consulting and a law practice, **Peter Philliou** presented a paper at the June meeting of the American Society of Engineering Education on "Energy Conservation for Schools." Peter's son graduated from Georgetown and older daughter from Brown. His younger daughter is at Concord Academy. His wife Helen is a rehabilitation administrator.

Named as a fellow of ASM International, the society for materials, **Gorden W. Powell** is a professor in the Department of Metallurgical Engineering at Ohio State University. The citation was "for outstanding contributions as a dedicated and inspirational teacher, for innovative research on diffusion and physical metallurgy, and for societal work in failure analysis." Dr. Powell lives in Worthington, Ohio.



PHOTO: SPENCE HOLLSTADT

"I carry around a statement that says, 'No problem is a problem if it has a solution.' And I believe most problems are solvable," claims Earl W. Eames, Jr., '49, manager of the Minneapolis/St. Paul office of Save the Children Federation (STCF). When he studied at M.I.T., certain professors encouraged him to focus on business administration and international problems, he says. Consequently, he has spent much of his life teaching people — mostly in developing countries — how to initiate and manage their own enterprises.

The STCF, a group that got its start during the Depression, providing school lunches for children in Appalachia, is now an $80 million-a-year agency doing relief work in 14 states and 46 countries.

Temporarily curtailed from his love of flying by a minor stroke, **Milo Wingard** is happily now fully recovered. His company is rapidly developing in western Massachusetts and northern Connecticut. He writes of his recent purchase of a home in Orleans on the Cape for future retirement.

Sadly we received word that **Daniel E. Magnus** died in last April. He was president and cofounder of KLD Associates, a research and development firm in Huntington, N.Y. He had many accomplishments in aerodynamics, computer science, and the development of an optical rail image analysis system. We extend our condolences to his wife Frances, his daughter Susan, his two sons, Steven and Daniel, and others of his family.—**Martin N. Greenfield**, Secretary, 25 Darrell Dr., Randolph, MA 02368

52

Arthur Martin has been named a senior vice-president of Paine Webber. He has been selling investments for them in Princeton for the last ten years.

Somehow this reminds me to say thank you to all our classmates who have shared news of themselves with us and to thank in anticipation those who will do so in the future.—**Richard F. Lacey**, Secretary, 2340 Cowper St., Palo Alto, CA

53 35th Reunion

The excitement is building! Our 35th reunion is only a few months away. I hope everyone has set aside time to attend so you won't miss a great time in Cambridge and Nantucket (for those who can take the extra time). Those of us who have retired or semi-retired should particularly be able to join the festivities. We're looking forward to renewing acquaintances with all our long-standing friends (I refuse to say "old" friends). Let's make this the best attended reunion ever.

We have a few notes about our classmates. **John G. Polk** is now senior vice-president of Triangle Industries, Inc. having left Primerica Corp. where he was president of packaging operations. . . . **Harris J. Bixler** was recently elected chairman of the Bigelow Laboratory of Ocean Sciences board of governors. He is also a member of the corporation for Woods Hole Oceanographic Institution. Last year he formed his own investment and consulting firm, Brown's Head Ventures.

Robert P. (Bob) Bonazoli writes that he is now the director of engineering for the U.S. Lighting Division of Sylvania, a company he's been with for 30 years. He is living in South Hamilton, Mass., and tells us that his third daughter has just married. Congratulations to all of you on the big events in your life.—**Wolf Haberman** , Secretary, 41 Crestwood Dr., Framingham, MA 01701

54

Ron Lovasz has been appointed vice-president, Quality Control, Research Division, by the board of directors of Gerber Products Co. in Fremont, Mich. He has been with the Gerber Co. since 1959, holding the positions of research mathematician, quality control manager, director of quality control, foods, and director of corporate quality control. He and his wife Patricia live in Fremont.

Otherwise, things are very quiet. Drop us a line if you have a minute.—**Edwin G. Eigel, Jr.**, Secretary, 33 Pepperbush Lane, Fairfield, CT 06430; **Joseph P. Blake, Jr.**, Assistant Secretary, 74 Lawrence Rd., Medford, MA 02155

55

Harold C. Wells has been appointed executive vice-president of Systems Group of M/A-COM. In his new role, Harry will have responsibility for government systems which is a consolidation of several M/A-COM operations on the east and west coasts. Harry has served in both marketing and operating positions during the 24 years that he has been with M/A-COM. He resides in Concord, with his wife Beryl and three children, two of whom still live at home.



M. Hablanian

The American Vacuum Society, an organization of scientists and engineers associated with high vacuum technology which is affiliated with the American Institute of Physics, will present The Albert Nerken Award to **Marsbed Hablanian** of Wellesley, Mass., in November '87 at the 34th National Vacuum Symposium. After an initial education in Europe, Mars attended M.I.T. receiving both B.S. and M.S. degrees in mechanical engineering. In 1957 he joined the National Research Corp. (which subsequently became a part of Norton Co. and later Varian Associates) serving as a development engineer, manager of the R&D department and manager of engineering. He was a principal contributor for three U.S. Air Force projects involving airborne diffusion pumps, cryogenic traps and epitaxial reactors, and made substantial technical contributions to the art of vacuum components and system design. His team was first to demonstrate the ability of large diffusion pumps to reach pressures low enough to lead to the creation of large space simulation systems. The NRC team was involved in the design of pumping systems for the majority of large space simulation systems in the United States in the 1950s, and the vacuum gauges placed on the moon were designed and built in the NRC laboratory. Mars is the inventor of the high-speed, wide-body diffusion pumps which produced 50 percent improvement in pumping speed without significantly increasing the overall size of the pump. Several other important technical developments were achieved under his leadership ranging from ion pumps to leak detectors. Mars has been active in the American Vacuum Society as a member of the board of directors, chairman of the standards committee and in other positions. He has also been active in the New England chapter of the Society and has an extensive publications record.

Russ Meyerand is prominent in the M.I.T. news again because of United Technologies Corp.'s (UTC) sponsorship of M.I.T.'s Daedalus project. UTC has pledged $430,000 as well as engineering and materials assistance to become the project's primary sponsor. The aircraft will be used this coming spring to attempt a flight of more than 70 miles, starting from the Greek island of Crete, in a symbolic recreation of the mythical flight of Daedalus. The flight from Crete will be the third phase of a three-year education and research program aimed at advancing the technology of low-speed flight. In January 1987, the project's prototype aircraft, *Light Eagle*, established a new world distance record for human-powered flight of 36.4 miles at Edwards Air Force Base in California. The previous record of 22.5 miles had been set in 1979 on a flight across the English Channel. Russ, UTC's vice-president and chief scientist, said the Deadalus Project was an attractive and logical choice for United Technologies participation. "As a high technology company, UTC is always seeking imaginative approaches to engineering problems," said Meyerand. "This project represents a unique collaboration of scientists, engineers and students united in their efforts to realize man's dream of flight through creative application of technology. It is a project of great human interest which has the potential of making a lasting impact on aviation history," he said.

Also in the news was **Marvin L. Tanzer**, M.D., professor and head of biostructure and function at The University of Connecticut Health Center, who has won an award of over $900,000 from the National Institute of Health to carry on work in understanding a biochemical agent that controls the function of many of the body's organs by regulating with calcium within cells. Tanzer's project is called "Structure, Function and Properties of Collagen," an umbrella title he has used in the past 19 years to cover a variety of sophisticated studies in the form-giving protein without which, he once said, "we would all be puddles on the ground." His research has gained him a worldwide reputation. He has been a visiting professor in Japan, Sweden and France and he spent a sabbatical year in Belgium, looking for answers in a peculiar collagen disease in cattle there. His current studies deal with the genetic structure and molecular architecture of large collagen strands that organize the connective tissue between cells. It is thought that these strands, among other functions, play a role in regenerating nerves and in nerve-muscle development. A better understanding of collagen's function could be applied to acquired and hereditary diseases of the connective tissue. Tanzer, 52, has been with the Health Center since 1968. He is a graduate of M.I.T. and New York University School of Medicine, and taught and did research at Harvard University before joining the Health Center.

Keep those cards and letters coming.—Co-secretaries: **DuWayne J. Peterson, Jr.**, 201 E. 79th St., New York, NY 10021; **Robert P. Greene**, 37 Great Rock Rd., Sherborn, MA 01770

56

Have a rewarding year. Time does have a way of moving on, especially when you have class note deadlines some three months in advance. At the moment of this writing, Secretary George is still savoring a trip he lead yesterday up Cannon Mountain in some of that beautiful autumn weather that occasionally graces New England.

Roger Borovoy wrote to comment on our comments on the 30th reunion. Brenda and he thought it was fabulous. The rain did not dampen people's spirits and the dinner at the Astor Mansion was spectacular. He gives a huge round of applause to the planners. It has been four years since Roger has written to *Technology Review*: he has changed careers again. Four years ago he left Intel where he was vice president and general counsel, and joined a venture capital partnership. They raised and invested $60 million. He is now back into the practice of law with the firm of Brown and Bain in Palo Alto, Calif., with whom he has worked closely for 18 years. He will continue to specialize in intellectual property law, particularly patent infringement, trade secret misappropriation and software copyrights. Fortunately he and Brenda do not have to move and will continue to reside in the same house they have been in for the last 19 years. Roger and Brenda look forward to the 35th reunion.

Just in case you did not read your June 30 *Daily Transcript* of Dedham, Mass., **Philip Trussell** has been elected to the board of trustees of North Hill, a life-care retirement community in Needham. Trussell, director of real estate and associate treasurer at M.I.T. holds a B.S. in building engineering from M.I.T. and an M.S. in civil engineering from Northeastern University. North Hill is part of the Weitz Corporation of Des Moines, Iowa, founded by its president, Frederick Weitz, an M.I.T. graduate of 1951. Several Draper and M.I.T. people reside at North Hill. Phil and Priscilla's oldest daughter lives in Sandwich, Ma., with her husband where they are active in sailing and a millwork firm. Their youngest daughter is with Magnetic Resonance Detectors of Burlington, Mass.—**George H. Brattin**, Co-secretary, 39 Bartlet St., Andover, MA 01810, (617) 470-2730; **Irwin C. Gross**, Co-secretary, Sweets McGraw-Hill, 1221 Avenue of the Americas, New York, NY 10020, (212) 512-3181

57

We learn that **Dick Brandes** has been named senior vice-president of Hughes Aircraft Co. (division of General Motors Corp.). He was previously president of the Electro Optical & Data Systems Group, a division of Hughes Aircraft Co. . . . **James Meditch** has been appointed associate dean for academic affairs of the College of Engineering of the University of Washington. . . . **Dexter Olsson**, who was senior metallurgical engineer in the Quality Assurance Division of Bethlehem Steel Corp., has retired after 30 years of service. He is a pioneer in the development of steel quality assurance programs.

We are saddened to learn that **David Landon** died suddenly on March 14.

The class held two reunions last spring. Those who attended the June reunion in Cambridge not only enjoyed a good time and had a chance to see old friends again but also experienced beautiful weather for the first time in recent reunions. A small group assembled in Bermuda in April for a pre-reunion. Thanks to the hospitality of host **Gary Dischell**, we had such a good time that there are now tentative plans to do it again, maybe next year. If you missed either of the reunions, you missed a good time.

This is my first report as your new class secretary. It is obvious that the quality and size of the reports depend directly on the news I receive from you. So, as the old saying has it, keep those cards and letters coming.—**John T. Christian**, Secretary, 23 Fredana Rd., Waban, MA 02168

58 30th Reunion

Welcome to the New Year. Hope your Christmas holidays were enjoyable and restful. Meanwhile, our 30th reunion committee has been busy planning your next "R&R" at the Harbor View on Martha's Vineyard for June 3-5, 1988. Members of the committee, at the time these notes are being written, include the following classmates: **Roy Scarpato**, **Martin O'Donnell**, **Frank Tahmoush**, **Dan Holland**, **Gary Fallick**, **Dick Rosenthal**, **Mike Brose**, **Glenn Strehle**, **Bob Jordan**, and **Pete Ricupero**.

For this reunion, the committee is making a special effort to bring together classmates who haven't seen each other for several years. If you are planning to attend the reunion, let the com-

mittee know who else you'd like to see there, and the committee will contact them. Since our 25th reunion, the Harbor View has managed to make further improvements to its already superb facilities. So, plan now for fun and sun, and surf and turf. Whether you're a health nut or a couch potato, the 30th reunion has something for everyone!

At the Foxboro Co., **Jim Graham** has been promoted to the position of senior vice-president. Previously, Jim had been vice-president of manufacturing for the company. . . . In New Haven, Conn., **Hillel Auerbach** has just recently opened his own law office. His practice will specialize in tax and financial planning, estate planning and administration, and partnership and corporate law. He and his wife Sara-Ann have three grown children, Alan, Jonathan, and Stephen.

Dick Rosenthal is heading up the Instrumentation and Measurement Systems Group at Polaroid, which builds all the test and instrumentation equipment for the research division as well as other divisions of the company. Dick's son and daughter are both graduating from college this year, and his son is going on to law school. Just this past year, Dick completed his M.B.A. degree. . . . Another long-time Polaroid manager is **Frank Tahmoush**, who is now heading up the firm's offshore purchasing activities. When I talked with Frank recently, he said, "It's an exciting job because I'm seeing places in the world I never thought I would see in my lifetime. Polaroid has developed overseas sources in Brazil, the Caribbean, and the Far East. About once a quarter, I end up having to take a one-or two-week trip to one of these areas to visit our suppliers." On the personal side, Frank and Karen now have a 3-year-old daughter, Heather.

We were indeed sorry to receive belated notification of the death of **Don Batten**, who graduated in Course XV. We extend our sympathy to his wife Judy and their family.

Be sure to watch your mail for more reunion news flashes. Please send in your class dues and your registration for the "Big Three-Oh."
—**Michael E. Brose**, Secretary, 841 Magdeline Dr., Madison, WI 53704

60

As is often the case in late summer, the news has been slow in reaching me. With the cooler weather you all are going to have to help me if we are going to have a monthly column. I recently spent a pleasant evening with **Bob Walsh** who was in Washington during his Air Force reserve active duty. Bob is a colonel and is assigned to the Air Force Judge Advocate General. In "real life" Bob is the general patent counsel for I.T.T's Defense Technology Corp. He and his family live in Mountain Lakes, N.J.

Bruce Silberg writes from Weehawken, N.J., where he is a currently-unemployed computer programmer-analyst. In 1965 Bruce was in an automobile accident that injured his short-term memory, but recently he had been editing the transliteration of a decision table compiler.

Recent press releases from ASM International, an educational society dedicated to materials science, named two class members as Fellows of ASM International. **Alan Ardell**, UCLA's chairman of the department of materials science and engineering, was honored "for outstanding contributions to the understanding of phase transformations and strengthening mechanisms in high temperature materials, using sophisticated modeling and analyses of structure and properties." **Thomas Courtney**, chairman of the department of materials science at the University of Virginia, was cited "for major contributions to our understanding of microstructural control and property improvements in alloys, particularly in composites and sintering, and for leadership in metallurgical education." Congratulations to you both!

Finally, best wishes to all for a happy holiday season and for all of 1988.—**Frank A. Tapparo**, Secretary, 15 South Montague St., Arlington, MA 22204

61

Henry Gabelnick hinted about big doings in his life when he was up here for the reunion a couple of years ago. They were only revealed in a letter that arrived in September. As of May 1987 there is a new Mrs. Gabelnick (Claire). In December 1986 Henry left the cushy life of a government worker and took a real job as professor of obstetrics and gynecology at Eastern Virginia Medical School in Arlington. He says "all that plumbing training in Course X finally paid off." He is also director of intramural programs dealing with contraceptive development.

Other changes in classmates lives include: **Jerry Grossman** becoming a director at A.D. Little in Cambridge and **David Pratt** leaving his position as CEO of Quantum Corp. in Milpitas, Calif. **Bill Scanlon** used to be president of the USM Machinery Group of Emhart but when the parent company was sold to some British interests he bailed out and got on the executive committee at the Beverly (Mass.) Savings Bank.

That's it on the news front for this month. Now for a little editorial. I am beginning an effort to improve the quality of M.I.T.'s libraries. The secret ingredient is money. They need lots of money. Perhaps you would be willing to direct your contributions to the Alumni Fund in the library's direction. Everyone at M.I.T. benefits from better libraries and they are available to the public as well. Money spent there have very wide effects.—**Andrew Braun**, Secretary, 464 Heath St., Chestnut Hill, MA 02167

62

Classmate **David Koch** mentioned at the 25th reunion (during his brief talk) that he had lots of money, but I don't think we expected him to turn up in the October 12, 1987, issue of *Fortune* on the exclusive list of the richest people in the world. There he is on page 121 listed along with the oil sheiks, kings and queens, with a story on page 153 about the family fortunes. Also mentioned in the article is twin brother **William Koch** (who also attended the reunion). We truly appreciate the generosity that these classmates have shown toward M.I.T. over the years.

The *Wall Street Journal* reported in July that classmate **David Dwelley** has been named president of the venture capital unit of Raytheon in Lexington, Mass. We congratulate David on his new position, a promotion from vice-president for administration and planning of the Beech Aircraft Corp. (a Raytheon subsidiary) in Wichita, Kans. . . . News from the *Burlington* (Vermont) *Free Press* that classmate **Robert Fiorenza,** a stalwart opponent of new taxes, is running for the school board as a Republican.

So what else has happened to our classmates since the reunion? I spent some time talking with **Marilynn (Arsey) Bever** at a fun party in Gloucester this past summer. She had more interesting things to discuss than just about anybody but my wife. "Buz" has been publishing books of poetry and gaining insights into human understanding at various study seminars as well as working full time with **Bojey Salmon** at Computervision. She asked me to help her find an interesting single fellow (preferably large and Scottish) who is not scared off by her intellectual pursuits, so I'm putting out the word. Somebody who fits this description is missing a good bet if he doesn't follow up on the request.

If you're not mentioned in these notes, it's only because you haven't written to me lately, so get with it. Drop a line to: **Hank McCarl,** Secretary, c/o McCarl and Associates, P.O. Box 352, Birmingham, AL 35201-0352

Widnall Wins Washburn Award

Sheila E. Widnall, '60, Abby Rockefeller Mauze Professor of Aeronautics and Astronautics at M.I.T. and president of the American Association for the Advancement of Science (AAAS), received the Bradford Washburn Award from the Boston Museum of Science late last October.



The Washburn Award, established in 1964, is given annually to a person who has made "an outstanding contribution toward public understanding of science and the vital role it plays in our lives." The award consists of a gold medal and a $5,000 honorarium.

As president of the AAAS, the award committee noted, Widnall plays a key role in guiding an organization that influences science policy for the entire nation. The AAAS is the world's leading general science organization.

The museum established the Washburn Award on the occasion of the 25th anniversary of its then director Bradford Washburn. Past recipients include test pilot Chuck Yeager, biologist and author Stephen Jay Gould, explorer Jacques-Yves Cousteau, television newscaster Walter Cronkite and science fiction writer Isaac Asimov. □

63 25th Reunion

It's nice to get news enclosed with contributions to the Institute, but it's even nicer to get direct delivery. For instance, a few months ago I got a call from **Roland Zapp**. Roland and I shared a cubby-hole office while we were both teaching assistants at the 'Tute, but I hadn't heard from him in years. It was nice to hear that he has a family and is doing well himself. Roland is a professor of electrical engineering at Michigan State, specializing in signal processing. His wife Roberta is an M.D. practicing internal medicine. They have a daughter majoring in biochemistry at Michigan State, and their son recently entered MSU to major in engineering.

I recently received a response to an earlier suggestion that you-all write on napkins if that's all that was handy. **Tom Lewis** wrote about one napkin's worth on plain paper. Tom is a computer consultant in New York City, apparently working mostly with financial firms. He has finished a stint with First Boston, and is now with Shearson-Lehman Brothers. Tom's wife Margaret just finished chairing the rebuilding of her church's organ, and is training her replacement as

church treasurer. His son, Tommy, 15, is now a high school sophomore, and last year played school football and tennis. Their second son Ian, 11, is now in seventh grade; last year he played flute well enough to travel to Hershey, Penn., for a competition. The family lives in Middletown, N.J. Thanks for the letter Tom.

A gratifying press release recently arrived. My old friendly adversary in Baker House, **Bruce Eisenstein**, has received some well deserved rewards. Last year he became a fellow of the IEEE. Now Drexel University, at which he is department head and professor of electrical engineering, reports the IEEE has named Bruce its 1987 Education Society Achievement Awards winner. This was for his distinguished leadership of the society (of which he was president 1984-85) and for expanding its professional development. A member of diverse engineering honorary societies, Bruce lives in Wyndmoor, Penn.

Stephen Evans tells us he is still in California, and still with Rockwell, where he is now program manager for space station propulsion. He lives in Canoga Park, and is chair of the M.I.T. Educational Council for the San Fernando Valley/Thousand Oaks region.

Steve Swerling is on leave (after five years service) from Mentor Graphics, of which he was a founder. The purpose is a one-year tour of the U.S. in a motor home. Steve, you don't know how many of us are jealous of you.

Yours truly is breaking a long-standing practice. After living many years in Baltimore City I am moving to the suburbs: Ellicott City (actually a small town). I'm buying a house not being resold (also a first for me). This will put me nearer to Frederick, Md., where Distribution Plus is located, a computer wholesaler where I manage the technical support department. I am afraid I may be going establishment. Hellllp!—**Phil Marcus**, Secretary, 2617 Guilford Ave., Baltimore, MD

64

A short column this issue—only a single press release. ASM International, a society for materials, announced that **John Morris** has been named a fellow in recognition of his outstanding contributions to the understanding and development of alloys for cryogenic service and for super-conducting magnets. John, a resident of Oakland, is a professor of University of California, Berkeley. He is a member of the faculty in the Department of Materials Science and Mineral Engineering.

Louise and I have been doing a lot of travelling in the Southeast recently with daughter Jennifer in search of a college for her for next September. Though we've been through lots of airports and hotel lobbies, no classmates were to be found; hence, no more news to report.

Please send some information about yourself, your career, your plans for the reunion, whatever. Thanks—**Joe Kasper**, Secretary, 3502 Idaho Ave., NW, Washington, DC 20016

65

I thought last month was the low point of the season in terms of quantity of notes for the column, but this month's envelope brings exactly one press release. **John Butler** has been named executive vice-president of Honeywell Bull, in charge of U.S. marketing, sales, and service operations. John joined Honeywell Bull last April after almost 25 years with Sperry.

I believe that this is the first column of 1988 even though it's being prepared in late summer. Happy new year to you all.—**Steve Lipner**, Secretary, 6 Midland Rd., Wellesley, MA 02181

66

I have received the sad news that **Peter Wolfe** died of cardiomyopathy in April, just a day before he was scheduled to receive a heart transplant. Peter majored in electrical engineering and his mother reports that he wore his M.I.T. ring with pride, and valued his years and friends at Draper Lab greatly. The family has contributed a scholarship fund to M.I.T. in Pete's name. The class offers them our deepest sympathies.

Marvin Schildkraut has been elected president and CEO of Presidential Realty Corp. in White Plains, N.Y. **Robert Poole** is with the Reason Foundation in Santa Monica.

William Dietrich got married last December to Elisabeth Pepperill, a graduate of Wheaton College. He is currently a vice-president at Manufacturer's Hanover in N.Y. . . . After living in Minnesota all his life, **William McGinnis** has moved his family to Poughkeepsie, N.Y., to take a job in the IBM patent department. He was a patent lawyer for Control Data for 14 years. . . . **Stephen Shapiro** now lives in Scarsdale, N.Y., with his wife Michele and two children. After graduate work at Berkeley and 13 years in the medical device industry, he has joined the Wilkerson Group, a consulting group, as vice president and partner.

That's what's happening in New York. Now for news from **Ralph Davison** in New Jersey. Ralph is working on stainless steels for Avesta Stainless. His wife Nancy is selling her own work and that of others at her gallery in York Beach, Maine. . . . And in Connecticut, **Dave Ljungquist** and his wife Carol are enjoying life. Dave has been named general manager of the communication products division of North Hill Electronics.

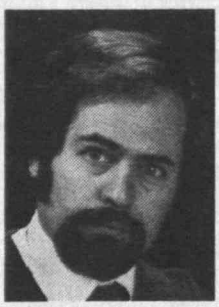
That's it for now. Keep those cards and letters coming.—**Jeff Kenton**, Secretary, 7 Hill Top Rd., Weston, MA 02193

67

Henry Ancona has been named vice-president of Business and Office Information Systems for Digital Equipment Corp., which he joined in 1972. Henry and Deborah live in Merrimack.

I regret to report that **David McMillan** died suddenly at his home in Winchester, Mass., on June 27. He is survived by his wife Marilyn, daughter Courtenay, a high school senior, and son Dwight, a high school junior. David was a loving and respected husband and father and is greatly missed by his family and friends. He especially enjoyed renewing ties with old friends and Phi Delt fraternity brothers at our 20th reunion in June. David had a very successful career and at the time of his death was head of the Space Defense Systems Department at MITRE Corp.—**Jim Swanson**, Secretary, 878 Hoffman Terr., Los Altos, CA 94022

69



Eugene Mallove

There's a great silence out there. I received no notes from anyone this month, so I have an opportunity to tell you what it feels like to step through a huge space-time warp and return to being on the M.I.T. campus for most of the day. It's pleasant nostalgia tinged with the awareness of father time. In early September, I was appointed chief science writer at the M.I.T. News Office. It's now my job to walk M.I.T.'s halls searching for compelling science stories to tell the M.I.T. community and, more important, the outside world. It feels like taking every course and seminar you ever wanted pass-fail and getting paid for it too! (The enthusiasm of a neophyte.) I write science stories for *Tech Talk* and make sure that the national press gets the word on scientific developments here. Cosmic strings, frontiers of immunology, superconductivity, Philip Morrison's new PBS series were on the menu in the first few weeks. Apart from my daily 62-mile trek via Concord Trailways to home in Bow, N.H., the job is exciting and fast moving. However, bus commuting is welcome enforced reading time.

Those of you who haven't been on campus for a while should see the changes! They're gutting the innards of our beloved student center to make room for more facilities. The M.I.T. Coop has moved to elegant quarters near the revamped Kendall T station. The futuristic buildings on that part of the campus are disorienting. I was used to the old grungy places.

Apart from certain hair style changes, the entering freshpeople look much the same. Many more women, of course. But as if to mark my emergence from the time warp, miniskirts have arranged a comeback! I almost felt like re-registering but realized that those delicious and feared courses were for the new generations. (Besides, I couldn't afford my own tuition!) Any of you already here on campus, or just visiting, please stop by and say hello to me in Room 5-111.

You'll have to excuse the interruption—I was just asked to help write one of the 1987 Nobel prize acceptance speeches! Guess which of M.I.T.'s three this year? (See page MIT 14, this issue.) How many times does that happen in life?—**Eugene F. Mallove**, 183 Woodhill-Hooksett Rd., Bow, NH 03301

70

Robert C. MacCready is living in Newton and has been promoted to the position of corporate controller for Town & Country Jewelry Mfg. Corp. of Chelsea. He is presently responsible for financial reporting, regulatory compliance, and the development of financial policies, procedures, and internal controls. . . . **James Pelagano** and his family have moved to Brookfield, Wisc., where he has accepted a position as assistant professor of pediatrics and clinical neonatology at the Medical College of Wisconsin in Milwaukee. He previously had received specialty training in neonatology at the United of Connecticut Health Center, after having done his residency at Bridgeport Hospital. . . . **Stephen Ryder** is now physician-in-chief as Paiser Permanente in Akron, Ohio. His spouse and two sons, 5 and 7, live in Cleveland Heights, Ohio. He is an avid curler during the winter months.—**Robert Vegeler**, Secretary, Beers, Mallers, Backs, Salin & Larmore, Attorneys, 1100 Fort Wayne National Bank Building, Fort Wayne, IN 46802

71

Benjamin Roberts is currently vice-president, engineering of Ocean Genetics (Santa Cruz, Calif.), a marine biotechnology firm he cofounded in 1982 and joined full time in 1985. He is also consulting assistant professor at Stanford. His second child arrived from Seoul, Korea, in May 1986. Both of his children are adopted. He writes, "Two small children, two careers, and a startup company makes life very busy!"

J. Andreas Howell has been transferred by the air force to the Georgia Institute of Technology to work for a doctorate in operations research. Following that, he will return to Wright Patterson AFB, Ohio, to teach on the faculty of the Air Force Institute of Technology.

Robert M. Churella writes, "I recently changed jobs and am now the senior litigation associate in

the Los Angeles office of Coudert Brothers, doing insurance coverage litigation and general business litigation. Our office is heavily involved in the representation of high tech and computer software companies. If anyone out there needs legal counsel, we'd love the opportunity to help.



Louis Metzger

Louis S. Metzger joined the MITRE Corp., of Bedford, Mass., as an associate technical director of the Tactical Communications Division in the C3I Group for Air Force Systems. He was formerly assistant vice-president at M/A-COM Government Systems, where he managed that firm's Boston Engineering Center. For nine years, he worked at M.I.T. Lincoln Lab. He earned his bachelor's, master's, and doctorate degrees in electrical engineering from M.I.T.—**Hal Moorman**, Secretary, P.O. Box 1808, Brenham, TX 77833

73 15th Reunion

A few items of note brighten the early fall days in Virginia. **Nicholas Loter** has been living "in matrimonial bliss" with Maureen O'Brien, '75, since last year. Accompanying their bliss are their two cats, residing with them in San Diego. . . . **David Otten** was part of the M.I.T. team winning a contest in London last July—their robotized "mouse" was the fastest to navigate a 10-foot square wall maze.

Scott Davidson and his wife Tish (now teaching at a school for nannies) have a new daughter, Susan ('08). Scott is supervising a group of 16 working on testing research for digital devices, while taking time to serve on the editorial board of IEEE Computer magazine.

Two letters arrived in recent weeks. **Ellen Spielman Gitler** has sent her first in 14 years. She lives in Mamaroneck, N.Y., working as an internist/endocrinologist at Kaiser-Permanente in Westchester. Her husband Bernie, '72, is in private practice as a cardiologist in New Rochelle. The Gitlers have three children, Stefanie ('04), Cyndy ('06), and Bryan ('08).

Jim Gregory writes that he is leaving Mobil Solar Energy after nine years to join the Microelectronics Group at Lincoln Labs. Nancy, Jennifer, and Hillary (two daughters and a wife, but ye secretary isn't positive which is which) are doing well. All live now in Sudbury, Mass.

The fifteenth reunion of the class of '73 is nearing. Make your plans to get together and meet these folk who have faithfully submitted their goodies to the class notes all these years. May even make it myself!—**Robert M.O. Sutton, Sr.**, Secretary, "Chapel Hill", 1302 Churchill Ct., Marshall, VA 22115

75

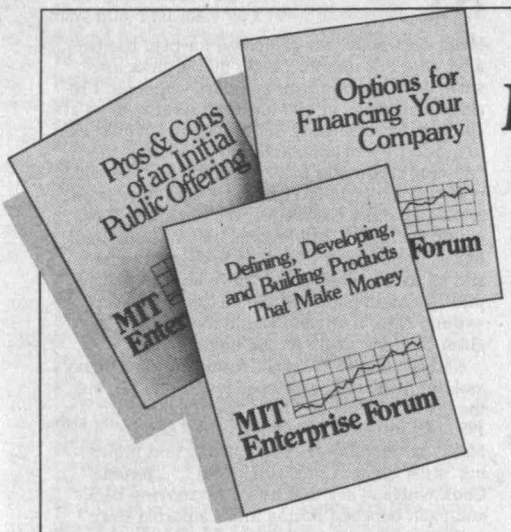
Leonard J. De Roma has joined Dean Witter Reynolds, Inc. as senior vice-president of Short Term Products. . . . **Charles J. Digate** has become senior vice-president, Software Products, of Lotus Development Co., Cambridge, Mass. He was formerly senior vice-president, International and Information Service.

Ru-Mei Kung continues his work at TRW, while **Lila Kobylak Kung** has spent the past year teaching science and math in the inner city. Says Lila, "What an experience."

I received a nice note from **Stephen Nimer**, who has been living in Los Angeles for the past eight years and has decided to settle down there. He joined the faculty of the UCLA School of Medicine in the Division of Hematology-Oncology. He was due to marry "a local girl" in October and planned to live happily thereafter. Congratulations to you both. . . . So why don't more of you write!—**Jennifer Gordon**, Secretary, c/o Pennie & Edmonds, 1155 Avenue of the Americas, New York, NY 10036

76

It is your secretary's very sad duty to announce the death of **Erland van Lidth de Jeude**. Erland died of heart failure September 23, 1987. He is survived by his wife, Annette, and his son, Christiaan, who will be about 14 months old when this is published, as well as his parents, a brother, and a sister. His passing has caught us all by surprise. He had recently finished another film, in which he co-starred with Arnold Schwartenneggar. His film credits include *Stir Crazy* and *The Wanders* and he was also in commercials. However, his acting career was just a springboard for his greatest professional love, opera, in which he had done various community works and was trying to break into as a career. When he was not making movies or singing, Erland had a very suc-



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cessful career as a systems consultant. He had recently helped start up a new company with some partners to develop and market software. However, during our last phone conversation, he indicated that the most important aspect of his life was his family. The birth of his son gave him a joy beyond my feeble powers to describe. When Erland and I last spoke, it was a conversation full of Erland's optimism and planning for the future. We will all miss him—a raconteur par excellence, teller of great jokes, bon vivant, and friend.

We will be starting a trust fund to raise money to pay for Christiaan's college education. Some of us (his M.I.T. friends) have discussed this and have come to the conclusion that we do not want a classmate's child to grow up without the opportunity of a college education (hopefully M.I.T.). For those of you interested in giving a donation, please write to me. By the time this column gets into print, I will hopefully have details on the trust and how checks should be make out.—**Arthur J. Carp**, Secretary, c/o Stalco Futures, Inc., 225 West 34th St., S. 1705, New York, NY 10122, (212) 736-1960

77

This month's column will be short through no fault of your own. It was written before you got my address in the last issue; but, be forewarned, in future issues, excuses will not be provided for you.

I had the pleasure of talking to our beloved president, **Charlie Shooshan,** on the telephone a few months ago. Charlie is an attorney splitting his Connecticut practice between Stamford and Newington, Conn. (where he lives). Therefore, he commutes about 1,000 miles a week, which even he concedes is a little stupid. He is in general practice, covering everything from "A" (affidavits) to "Z" (zoning appeals). Charlie has a pilot's license and manages to fly about 200 miles each weekend. In early September, he flew himself and his wife Chris to Nantucket for a nice vacation. Chris is a supervisor for the Aetna insurance company. Charlie keeps in touch with another Connecticut resident, **Kevin Miller**. Kevin, a psychiatrist, recently began a new job as director of the Alcohol Treatment Center at the VA Hospital in Northampton, Mass.

I have taken on a new role this fall as an advisor for a church youth group. I advise a group of junior high students who do service work in the community. It promises to be a fun and challenging enterprise. I hope to hear from many of you soon. I'd love to hear about your careers, your hobbies, your kids, your books, your millions, your political aspirations, whatever you feel is fit for this fine family publication.—**Ninamarie Maragioglio,** Secretary, 8459 Yellow Leaf Ct., Springfield, VA 22153

78 10th Reunion

You may have noticed a recurring theme in mail you've been receiving from the class of '78. Well, this column is no exception. Our 10th reunion is less than six months away, and you all should be there—yes, you too. Reunion is scheduled for June 3-5 in Cambridge; be there. Class of '77? '79? Come on along!

As she did five years ago, **Karyn Altman-Velasquez** is organizing the reunion; however, this time, she'll be getting a lot more assistance from the reunion committee, including **Jim Bidigare, Diane Curtis, Al Presser, Cindy Husman Berman, Joan Olsen, Regina Murphy, Phil Kesten, Frank Murphy, Frances Scovil** and me. And, we can always use more help, in Boston or anywhere in the country. Call Karyn at (617) 253-7665 or me at the number below.

Speaking of reunions, I got an impressive-looking news release from Frame Technology Corp. titled "Four '78 Co-ops Hold Mini-reunion at the World's Largest Surf Shop; Former VI-As Terrorize Cocoa Beach." And the story goes: "**Steve Kirsch, Jeannette Wing, Jim Roskind,** and **Kelly Pan** had a mini-reunion on the July 4th weekend in Cocoa Beach, Fla. They spent the weekend dancing, windsurfing, jet skiing, seeing (and setting off) fireworks, touring JFK Space Center, and, of course, stocking up on surfing gear at Ron Jons, the largest surf shop in the world. Notable events included: Jeannette went to a fast food drive-thru for the first time in her life (but she *still* has never had a milkshake!), and Kelly got a sunburn for the first time in her life. . . . Jeannette is a professor at Carnegie Mellon University; Kelly is a venture capitalist at Merrill Lynch; Jim is an independent software consultant; and Steve is president of Frame Technology, a company which makes publishing software for Sun workstations."

I got three welcome new boring postcards for my collection recently. **Rich Perlstein** sends one of a camel from his trip to Tel Aviv and Cairo. . . . Another of a camel comes from **Julie Keller Pease**. Julie and husband David took a seven-week trip to England, Scotland, and Ireland to celebrate the completion of David's M.B.A. and Julie's residency. She writes: "I'll be setting up a private psychiatry practice in Biddeford, Maine. See you at the reunion." . . . My third postcard is of Mr. Rogers ("Won't you be my neighbor?") sent by **Kathy Hardis Fraeman**. Kathy writes: "This is what having two kids will do to you—I've memorized his theme song." I appreciate the cards; thanks to folks like you, my collection is now expanding to a second shoe box.

Babies: **Sue Kayton** and her husband Michael Barclay write to announce the birth of Rachel Samantha in September. "I'm still teaching computer programming to the public school teachers and kids as a volunteer in my spare time, which has just diminished to practically zero. See you at the reunion!" . . . Denise and **David Woodruff** announce the birth of their daughter Natalie Marie last September. . . . I ran into **Zaurie Zimmerman** in a Cambridge supermarket. She and her husband are expecting their first child around Christmas. Zaurie plans to bring her new baby to the reunion.—and her husband too, of course. Zaurie reports that **Cheryl Allen** recently married, and is living in "The Oranges" in New Jersey. . . . And, I can't leave out our reunion chairperson and class treasurer, **Karyn Altman-Velasquez**, and her husband Ray, who are also expecting their first child this winter.

Michael Nathan writes that he is in his second year of residency in primary care internal medicine in Rochester, N.Y. He is considering doing work in medical anthropology and cross-cultural medicine after residency. . . . Also in medical training is **Lucy Everett**, returning to Richmond, Va., (from South Chicago) to train in anesthesia and critical care medicine.

Franklin Ching was recently re-elected vice-president of the Metropolitan Area Planning Council, a city planning advisory agency for the Boston area. Frank is also vice-president of H.W. Moore Associates, a transportation and environmental analysis firm. . . . **Neil Cronin** writes from an airplane, "working on inventions and planning to forsake Gauloises." . . . GE announced that **Montgomery Alger** has recently been named manager of the Polymer Systems Project at the GE R&D Center in Schenectady, N.Y. He'll be working on novel materials for food and beverage packaging.

Finally, there's me. I've now set a new record for longevity on a job—23 months and still enjoying it. But even better, my wife Yuko has graduated from the Sloan School and has found the perfect job as product marketing manager at Strategic Solutions, Inc., a start-up software marketing company in Waltham. . . . well, almost perfect. Once they get venture capital, she'll get paid. Until then, it's just like having her in school—just one income.

Send me letters, boring postcards, and gossip—and start your plans to come to the reunion. News and volunteers: call or write **David S. Browne**, Secretary, 50 Follen St., No. 104, Cambridge, MA 02138, (617) 491-5313

79

Not much news this month, and all of it courtesy of local newspapers. **Michael Kan** has been named assistant town manager of Windsor, Conn., according to the *Windsor Journal*. For five years, Michael has been a senior financial analyst for Crocker National Bank in San Francisco. He earned a master's degree from the Sloan School in 1980.

From the *Sunday Standard Times* of New Bedford, Mass., comes the news that **Michael Gifford** has been promoted to manager of Sonobuoy development for Sippican Ocean Systems. Michael has been with Sippican since January 1979. He and his wife Sonja live in Rochester, Mass.

Robert and I just returned from two and a-half weeks in Great Britain. He was speaking at a conference in Cambridge, while I was just there to party (although I did drop in on Mobil's London office while I was there). We spent time in London, Cambridge, York, the Lake District, Edinburgh, Bath, and Brighton. We had a great trip—very varied. He did quite well driving on the wrong side of the road!

On the professional side, in a few weeks I will be transferred to the Office Automation Department. After more than four years in telecommunications (more than two of them in my current position as operations supervisor), I am looking forward to the change.

In the Mobil cafeteria recently, I noticed a shiny new Brass Rat in front of me and introduced myself to Dax Prather, '87. His brother is an undergraduate at M.I.T. and plays on the M.I.T. football team, which he tells me is doing quite well.—**Sharon Lowenheim,** Secretary, 303 E. 83 St., Apt. 24F, New York, NY 10028

81

Hello everybody. My campaign for mail has been a bit slow this month. I hope that it picks up soon. After looking over our class yearbook, I realized that many of you have not written to us at all. In order to remedy this situation, I would like to introduce a new feature in this column, the "missing classmates file." In each issue, we will publish a list of 15-20 classmates who have been missed by other classmates. We hope that those who have been "out of touch," after seeing their names or names of friends in print, will write in and let us know what they have been doing. So, please send in names of the missing and keep writing! Also, if anyone would like to write a guest column, please let me know.

And now on to the mail. **Annie Laurie Murray** and her husband Gustavo de los Reyes, '80, are the proud parents of Alicia, born October 10, 1986. All three are living in North Reading, Mass., where they are busy "fixing and improving" their home. Congratulations! . . . **Jerome Cook** writes to say that he's been moving back and forth between Boston and California since graduation in various engineering positions. In 1986, he retired from engineering to pursue an M.B.A. at UCLA.

Duane Horton, who entered with our class but graduated from Penn State University, writes to say that for the last three years he has been a torpedo designer at the Naval Underwater Systems Center in Newport, R.I. Duane says that he still plays softball and hockey and wishes to say hello to Zeta Psi fraternity brothers. . . . **Chris Svendsgaard** has been promoted to assistant secretary/assistant actuary at North American Reinsurance Corp.

On to the grapevine. My sources tell me that **Linda Stoloff** and **Joe Carangelo** graduated from Stanford Business School this spring. Joe has stayed on the West Coast, where he is working as a consultant at Touche Ross in Los Angeles. Linda has moved East to the "Big Apple," where she joined the investment banking firm, First Boston.

Closer to home, **Phil Brannigan** is a vice-president with First Winthrop, a Boston-based real estate firm. Phil and his wife Diana are moving to Wellesley from Back Bay.

And now, on to the missing classmates file: **Andy Meade, Diane Libowitz, Gail Cooper, Peter Schubert, Nora Fong, Dave Lerner, Chip Hance, Therese Prisby, George Dowd, Stephanie Acker, Lei-Ching Chou, Libby Guethlein, I-wen Huang, Carl Nowiszewski, Doug Savage, Karen Samuelsen**. If you are or have heard from any of these, please write!—**Lynn Radlauer Lubell**, Secretary, 216 Beacon St., Boston, MA 02116

82

Happy New Year! **Richard Segal** may have spent New Year's eve in London, where he is working for Salomon Brothers and living in a house once owned by James Clerk Maxwell, of the four equations. Richard had been working for the firm's New York office for three-plus years, during which he was in regular contact with a number of M.I.T. alums. Richard did make it across the Atlantic for last August's wedding of **Russell Murphy, Jr.** and Susannah Wurgler Murphy, '84. Russ is working as an associate with Temple, Barker and Sloane, a consulting firm in Lexington, Mass., after graduating from Harvard Business School last June.

Other educational achievements: **Charles Hobson** graduated from the University of Virginia medical school last June and is doing an internship in general surgery there; next June he will switch to neurosurgery. . . . **Andre LeClair** received his Ph.D. in physics from—horrors—Harvard Last June; he and his wife Julie are living in Princeton, N.J., where Andre is a research assistant.

Dr. **John Hollis** (he wanted us to emphasize his new title) and his wife Cheryl have recently moved to Georgetown, Tex., (population: 13,500+2). John is an inspector for the U.S. Department of Agriculture, a job that comes complete with "official car, credit cards, expense account, and exposure to zoologic diseases." He and his wife were hoping to visit **Howard DeWied** and his wife Nancy in time for their wedding anniversary. . . . East Coast correspondent **Linda Schaffir** recently visited the new suburban New Jersey manse of **Jonathan Cohen** and his wife Pam. Jon was recently featured in a full-page color photo in the annual report of his employer, Johnson & Johnson, playing with goo. . . . Jon's Burton house roomate **Ted Baker** was visiting from California, where he is on the verge of completing the Ph.D. he's been working on for the last five years.

Speaking of our correspondent, don't forget that you have three choices of folks to write to about your lives and activities. The West Coast correspondent is **Michelle Gabriel**, 656 S. Fair Oaks Ave., D-211, Sunnyvale, CA 44086. The East Coast correspondent is **Linda Schaffir**, who wants to remind everyone that Norwalk, Conn., is part of the greater New York metropolitan area and anybody passing through should look her up at 18 Prospect Ave., Apt. B-2, Norwalk, CT 06850. And I, of course, will take letters from anyone, anywhere.—**Stephanie Pollack**, 33 Trowbridge St., Cambridge, MA 02138

83 5th Reunion

Greetings fellow members of the class of 1983. You will never guess what big event is coming up! That's right, our five year reunion. As you all remember from previous articles, our class reunion will be held on Thursday, June 2nd, through Sunday, June 5th, 1988. Plans will be in place within the next month, but they are still not solidified as of this writing. The major thing now is for everyone to show up. As I stated in another column, the alumni office is expecting about 100 of us. I think they are crazy, especially since we have had so much time to make the necessary arrangements. Let's hope everyone is in attendance.

With that announcement, here is the news. **Dolores Contreras**, or should we now say, Doctor Contreras, was awarded her doctorate from the University of Texas Health Science Center in San Antonio in May. Her residency plans are to stay at the university and complete her time there. It's a great accomplishment Dolores, Congratulations.

The man with the silver pen returns to M.I.T. Some of you know him as **Eric Flemming**, but many more of you know him as the sports writer for the Tech. Eric has finally completed his fourth year as an assistant director for Yale's varsity athletic program. The good news is that Eric is returning to M.I.T. in the fall of '88. His testimonial is that Yale's athletics are okay, however, it just does not stack up against the 'Tute.

David Dombrowski is off to the world of high finance. He just completed his degree in business administration at Xavier University of Ohio. Dave was not sure exactly how he was going to utilize his degree, however, he said he did know it would be lucrative.

And now that special moment. Even though this is a short column, it does not preclude us from naming a Celebrity '83 for this issue. This column's celebrity is sort of a team. This team has managed to have its relationship endure through easy as well as some pretty rough times. Let me begin my story. **Keri Yura** has been working as a field engineer for DuPont since graduating. Her life was extremely boring. She spent the first two years of her life on Freon, then on Electronic imaging R&D, and now simply traveling around the world. Her life was so uneventful before he walked into her life. That's right, **Bill Benack** was no ordinary man. He spent three years serving on the USS Kalamazoo. During that time he managed to get over to Beruit during the TWA hostage crisis. For his exemplary action he was soon promoted to lieutenant and is now seeing action as a recruiter in Iselin, New Jersey. Somewhere between the TWA event and Dusseldorf, Germany, Keri was reacquainted with Bill. The brief relationship they had at M.I.T. only kept Bill wondering what life would be like without Keri. Bill, being an officer and a gentleman, took Keri as his bride at the next available opportunity. That opportunity happened to be a half Catholic/Buddhist event somewhere in the Mediterranean. They are now living happily ever after in Cherry Hill, New Jersey. And because they had such a wonderful story to tell, **Keri** and **Bill Benack** are this issue's Celebrity '83ers.

My major concern is that everyone remembers the reunion. **Al Bashawaty**, '84, and myself will be taking a little holiday overseas. We will be gone for a couple of weeks so I am sure that I will have a lot to tell in my next column. Thanks again and keep the letters coming. See you at the reunion.—**John E. DeRubeis**, Secretary, 14 Charles Ave., Port Washington, NY 11050

84

Sunday, 8 p.m., and I've been asked to write a class notes column by Thursday. I put aside my microeconomics textbook. Dare I get into trouble spreading rumors about my friends again? No. I'll call them and get them to tell me nasty rumors about their friends.

From **Jerry Shapiro**, who is at M.I.T. working on his Ph.D. in electrical engineering: **Michael Fu** is getting his Ph.D. in applied math at Harvard. . . . **Steve Untersee** is teaching science in Botswana, Africa. . . . **Barry Kornstein** sends his best from University of Minnesota, advising Jerry that "it's always best to keep at least one plate about to fall off the stack."

From **Liz Bashoff**, who's studying for the medical boards, but took a day off to visit me in Boston: Liz visited **Sarah McCord** in Los Angeles. Sarah is planning to start her Ph.D. in mathematics at University of Washington.

From **Jesse Treger** who has moved from working for the Gary Hart campaign to campaigning for Joe Biden: **Dale Rothman** is in Chicago finishing his master's degree in environmental policy and working full time for Argon National Labs. . . . **Colleen Vietz** is finishing her Ph.D. at Brown in cognitive sciences.

From an anonymous senior house source: **Rob Schuster** is in Washington working for DEC. From the friend of an anonymous senior house source: **Jesse Treger** is living in Brookline training for the Iron Man competition.

I had dinner with **Russell Siegelmen** and Beth Kernam (Sloan, S.M. 84). Russ is in his first year at Harvard Business School. Several M.I.T.ers are there this year, including **Eric Brandt** who is in Russ' section.

From **Cathy Naylor**: Cathy recently went to Sunnyvale on business where she visited Nancy Beckman. Nancy no longer promises to return back East. It seems she's addicted to the California lifestyle. Beckman, where's your sense of asceticism?

From the alumni office: **Suzannah Wurgler** and Russell Davis Murphy Jr., '82, were married August 1 in Wellesley. Suzannah is working on her Ph.D. in biochemistry at Harvard. . . . **J. Wallace Davies II** received a master of applied human physiology degree from Hahnemann University in June. He plans to attend medical school this fall.

Well, now that I got my friends in trouble, I may as well spread my own rumors too: **Stella Hetelekidis** is back in Boston, doing med school rotations in the area. Some of our classmates who are at the 'Tute working on Ph.D.s are **Mark Kolb, Barbara Moore, Kathy Dabulis, Charlie Oppenheimer, Jerry Shapiro** and **Joe Izatt**. . . . **Sarah Tabler** visits from time to time, and last time I saw her she was hoping to move back here. . . . **Charlie Marge** is working at A.D. Little and is often on campus. **Ellen Williams** has switched fields from neuroscience to computer programming.

The last time I visited San Francisco I ran into **Iris Cheng** in the Richmond District. She's back at UCSF. . . . **Mona Wan** recently changed jobs to work for Alza Corp. She writes that **Heidi Brun** married David Goldfarb on August 30. . . . And speaking of the California crowd, **Marina Buchman** moved to Mountain View with her husband Sasha (we miss you Marina).

As for me, after a summer of goofing off—traveling to West Africa, England, Iceland and Canada's Maritime provinces—I'm back in Boston at M.I.T. working on my master's at Sloan. Other M.I.T. grads in my class include Ruby Chandy '82, George Jacquette, '85, and David Spitz, '86.

On a sad note, I regret to announce the death of **Steven P. Kohler**. His home address: P.O. Box 697, Rte 1, Fogelsville, PA 18051. He is survived by his wife Lori Kohler.—**Lisa Tener**, Treasurer; Address news to: **Mona Wan**, 12231 Viewoak Dr., Saratoga, CA 95070

85

Hello everyone! I received a letter from **Michael Druding**. He was recently married to Cheryl Martin (Purdue). The wedding followed his graduation from Iowa State University, where he completed his M.S. in chemical engineering. Both Cheryl and he work as process engineers at Corning Glass Works in New York state. They have been busy moving to their new house which overlooks the valley.

Alec Atkin writes that he has been learning to surf! He's been practicing in Hawaii, where he visited **Celia Lee**. Celia just received her M.S. in mechanical engineering from M.I.T. He says he can now "rip and cut" and, in true surfer spirit, is living in a beach house on the Balboa Peninsula. Alec works for a small company called Rosemount Analytical, Uniloc Division. Last June he was in Boston for the wedding of **Ajit Kambil** and **Andje Quaadgras**. At the wedding he met up

with **Dave Lyon** and **Eric Chang**. Eric is attending Albert Einstein Medical School, and Dave is working in the Bay area.

I also heard from **Will Sauer**. After eight months of job hunting, he has found a good position with the U.S. Bureau of Mines in beautiful Albany, Ore. He started last May as a metallurgist and is rapidly getting involved in various interesting projects. He is improving on his running and tennis now that M.I.T. doesn't occupy 95 percent of his mental energy!

One last bit of news. Jeff and I will have moved to Japan by print time. We are working for a Japanese start-up called Custom Technology Corp. We plan to return to the states in three years—just in time for the 5th reunion! Please note the address change (it's my old one), and I will give my Japanese one in the next issue!—**Stephanie Winner**, Secretary, 3511 Shafer Dr., Santa Clara, CA 95051

86

Salutations. Thanks for all the letters. **Sharon Israel**, having moved from Philadelphia where she worked for GE, is now in Atlanta attending Emory Law School. She says **Cheryl Ingram** is still in Philly at University of Pennsylvania. . . . **Yong Mi Choi** transferred from Princeton to UCLA, where she's working on her Ph.D. in chemistry. . . . **John Villani** is back in Syracuse thinking about law school. . . . **Marta Diaz** graduated in June and is working in Boston, where **Mary Ystueta** is also, working for Wang. . . . **Hannah Bond** is still working for Corning, and **Rose Joseph** is employed by IBM in Poughkeepsie, N.Y. . . . **Beth Dernbach** is with American Systems in northern Virginia, and **Alka Jain** is working for Jouche Ross in New York City.

Stephen Andes has moved from GE's Aircraft Instruments plant in Wilmington, Mass., to GE's Drive Systems plant in Roanoke, Va., where he's having an interesting time. . . . **Ken Chen** and **Ralph Spicer** are employed by Ford Aerospace in Palo Alto, Calif., and **Harish Sangani** is in grad school at Stevens Institute of Technology in Hoboken, N.J. . . . **Al Rizzi** is working with Eden Warner, '85, for Northrop in Los Angeles, and **Paul "Chad" Ramos** is with General Dynamics in Ft. Worth, Tex.

Darryl Robinson resigned from Polaroid in order to start a consulting firm. He also fit in a trip to Los Angeles, where he became a Venice beach bum by day and a Westwood inhabitant by night.

Lieutenant **Noel Zamot** got his master's from Michigan and is now at Mather AFB, Calif., undergoing navigator training. He was selected for Electronic Warfare Officer Training which he says is pretty cool. He also writes that **Jim Morehead** is getting a Ph.D. at Berkeley, and **Mark Neumann** is doing okay in New York. . . . Lieutenant **Jim Nugent** recently arrived in Los Angeles; he will be working at Space Division (along with me, **Sonya Sakai**, and **Greg Harrison**). . . . Lieutenant **Karl Tucker** also recently arrived in California at San Bernadino where he'll be working for the Ballistic Missile Office at Norton AFB along with **Matt Phelps** and **Don Davidoff**. . . . Lieutenant **Karin Getschow** arrived for duty at the Harry G. Armstrong Aerospace Medical Research Lab at Wright-Patterson AFB, Ohio.

Andy Solem wrote in from 34,000 feet over Ohio. He's currently pursuing a master's at Toyko University in aero/astro. He writes that **Henry Hoeh** is driving his new "woman magnet" Porsche at Grumman in Long Island, **Dave Kranzler** is hopping among electronics companies in Silicon Valley, **Mike Kardos** is at Stanford (although he spent the summer designing interesting hygienic aids in Cincinnati), and **Mike Maguire** is shaking the financial world in Manhattan. . . . **Jim Hall** is learning how to mollify conquered territories in the army reserve and, after serving a stint as a Domino's Pizza delivery boy, is once again contemplating medical school.

Marc Friend recently resigned from the Aerospace Corp. in El Segundo, Calif., to start his own business firm and is looking for **Benge Ambrogi**. Drop me a letter, Benge, and I'll pass it on. . . . **Chris DaCunha** was out in Los Angeles recently for a conference. Chris works in Boston and seems to be having a wonderful time. He's also planning a visit back home to Nairobi, Kenya. . . . **Anne Fricker** met **Ellen Epstein**, **Karen Wohl**, **Mark Emineth**, **Dan Pyne**, and Jim Manzi '84, in New York City for a wild weekend of partying in September. Karen, who works for Merrill Lynch, did some recruiting at Harvard and M.I.T. and will be in San Diego for Thanksgiving. . . . **Mark Caylor** and **Joe Bush** are living in southern California. Joe is employed by Hughes Aircraft Co.

Mike Cangialosi is a grad student at Brown in computer science. . . . **Peter Caporal** is employed by BTI Systems Inc. in Oklahoma City. . . . **Rina Cerulli** works for Lin Associates in Brookline, Mass. . . . **Hei Chen** is a grad student at M.I.T., and **Christine Chan-Lizardo** works for DEC in Littleton, Mass. . . . **Albert Chang** and **George Chen** are working, along with **Grace Tan**, at the Jet Propulsion Lab in Pasadena. . . . **Julie Chen** and **Thomas Chang** are grad students at M.I.T. . . . **Elizabeth Chen** is at Cornell, and **Grace Chen** is an underwriter for the Prudential Insurance Co. in Parsippany, N.Y. . . . **Wayne Chen** is employed by Raytheon in Lexington, Mass. . . . **John Cheng** is at Carnegie Mellon, and **Cary Ching** is with IBM in Hopewell Junction, N.Y.

Sanjeev Choudhary works for GE in Lynn, Mass. . . . **Chris Chow** is at Johns Hopkins Medical School. . . . **David Cinquegrana** is at University of Lowell. . . . **Ted Clampitt** is with Radionics in Burlington, Mass. . . . **Lianna Cleland** is with Computer Information Systems in Braintree, Mass., and **Andrea Cochran** is at Berkeley. . . . **Tim Coe** works for Vitesse in Camarillo, Calif. . . . **John Coffee** and **James Courtemanche** are grad students at M.I.T. . . . **Crystal Coleman** is at University of Washington. . . . **David Collins** is at University of Minnesota. . . . **Chris Coppin** is at Tufts Medical School, and **Craig Corp** is a Ph.D. student at Emory. . . . **Karen Covert** is at the Sloan School of Management at M.I.T. . . . **Robert Craig** is with Westinghouse Electric. . . . **Herman Crank** is a consultant with Booz, Allen and Hamilton in Bethesda, Md., and **Dennis Cuy** works for TRW in Odgen, Utah.

Well, folks, that's it for this month. Keep up the good work.—**Mary E. Cox**, Secretary, SD/CLTP, P.O. Box 92960, LA AFB, Los Angeles, CA 90009-2960

87

Well, this is it—our first class notes. Do you feel different now that you've graduated? If you miss those problem sets, you can keep yourself busy by writing me letters.

Jim Lin, class treasurer, writes that the class didn't make quite as much money as expected. Unfortunately, this means that plans for calling the class secretary collect will have to go on hold. Jim also wrote that he and **Krishna Komanduri** are having a great time at medical school—Jim at University of Chicago and Krishna at the University of Minnesota.

On the local scene, **Gene Cohen** (CitiCorp), **Herman Reyes** (finishing up M.I.T.), and **Dave Maes** (graduate student at M.I.T.) had a party in their new apartment a couple of weeks ago and a few local class members were there. **Dave Jesurum** (LTX) was there with his roomates. **Stan Oda** (LTX) and **Chris Young** (finishing up M.I.T.). **Wendy Cone** came in from Fitchberg, where she's teaching at St. Bernards High School. **Jim Clarke** (Acoustic Technology) and **Alan Gordon** (Design Options), also living in scenic Somerville, were there but left their apartment-mates Mike Keirnan and John Hamilton, '86, at home. **Toai Doan** was there and is enjoying his job at DEC in Shrewsbury.

Dave Napoli, **Dave "Bug" Chen**, and **Rob Hubal** came to visit the Boston crowd recently. **Dave Napoli** is living in Brooklyn, N.Y., attending DownState Medical School with **Rachel Chin**. . . . **Dave Chen** and **Rob Hubal** are living together in Brooklyn and are both working for Arthur Anderson. . . . **Ken Corless** (Arthur Anderson) also flew in for the weekend from a business trip in Chicago. . . . While I'm on Wall Street, **Maria Kozloski**, **Felix Partow**, and **Mike Schoen** are all living in Manhattan and working at Morgan Guarantee.

I spoke with Andres "Reggie" Grandea, '85, and he told me about some of his fraternity brothers at the Delt House. He is living with **Jordan Levin** (Sylvania Tech) in Salem, Mass. . . . **Marc Bloshinsky** is working in Washington, D.C. for American Management Systems. . . . **Jon Kramarsky** is living in Brookline finishing up at M.I.T., and **Bob Vokes** is working for McKinsey in Cambridge. . . . On a lunch break about a month ago, I bumped into **Evan "Elmo" Pratt**. He's doing construction work on a 31-story building in downtown Boston. He told me that he's been hanging out at the "Thirsty Ear" on Thursday nights.

Last Thursday night I decided to check out the "Ear." **Mike Foley** (M.I.T. graduate school) and **Janet Zahradnik** (M.I.T. graduate school) were there with Janet's apartment-mates, **Jeff Klohr** (M.I.T. graduate school), **Rod Moreno** (finishing up M.I.T.), and **Sue Hughes**. Sue just got back from a vacation in Greece and Spain and is waiting for flight training school in April. Janet told me about some friends of hers from DKE. . . . **Tom Devlin** is at Art School in London. . . . **Jon Kain** is at graduate school at Tufts. . . . **Dave Luneau** is living in Hopkinton, N.H., working as an engineer. . . . **Steve Hoenig** started Columbia Medical School this September. . . . **Walter Rho** also began his first year at Columbia Medical School.

A going away party is planned for **Geoffrey Kelsch**. He's heading out to San Diego soon for Surface Warfare School with the U.S. Navy. . . . **Tom Hoffman** (Proctor and Gamble) and **Michael "Killer" Roberts** (M.I.T.) will be cooking the Buffalo Chicken Wings. Unfortunately, some recent D.U. grads won't make the party. . . . **Eric Andrews** (Comstat) is living in Washington, D.C. . . . **Korey Kerstetter** is in the U.S. Air Force Reserve and attending University of Michigan graduate school in electrical engineering. . . . **Arie-William van Doorne** is working for Digital in Colorado. . . . Two other class members, **Eugene Pan** (NCR) and **Steve Mackler**, are also living out in Colorado.

I just go an update from **Dan Kennedy** in the Bay area. Dan is working at Oracle along with **Tim Jones** and **Brian Hirano**. . . . **Jay Cohen** is finishing his co-op at Fairchild, and **Heejung Koh** is working for a small bio-engineering firm. . . . **Susan Fields** is at Lockheed. . . . **Ken Munson** is at Amdahl. . . . and **Todd Malone** is working for Ford Aerospace. . . . Also in the Bay area, **Billie Gordon** and **Selena Spear** are studying architecture at Berkeley, and **Andrew Plump** is at medical school at UC, San Francisco. In southern California, **Dave Koehler** is studying medicine at UC, San Diego, and **Stacy Weinstein** and **Greer Tan** are working at the Jet Propulsions Lab in the Los Angeles area.

Back in Boston, **Ken Kharbanda** and **Grace Ueng** are working for Bain and Co. Grace tells me that she had a super summer in Taiwan and is now filling up her extra time taking Chinese and ballet classes. . . . **Jon Gruber** is a grad student at Harvard (economics), and **Matt Kaplan** is working at the Cambridge Institute for Information Systems (and as a singing waiter on the side). . . . **Lowell Kim** just gave up his summer job as a limousine driver and started working at Raytheon. . . . Finally, I've been working for an architecture firm (Cannon) in downtown Boston. I'd love to have more information to write about. Please send me a letter.—**Stephanie Levin**, Secretary, 3201 Eighth St., Charlestown, MA 02129, (617) 242-1618

COURSE NEWS

I CIVIL ENGINEERING

Richard M. Simon, Ph.D.'72, has been named as the fifth principal of the geotechnical engineering/environmental consulting firm of Goldberg-Zoino & Associates., Inc. (GZA), Newton Upper Falls, Mass. GZA also announced the promotion of **Mark D. Bucknam,** S.M.'82; **Nicholas A. Campagna, Jr.,** S.M.'67; **Frank W. Clark,** S.M.'79; **William E. Hadge,** S.M.'79; **Charles A. Lindberg,** '78; **Theodore von Rosenvinge IV,** S.M.'80; and **Duncan W. Wood,** S.M.'76. Campagna is now senior associate, the other six associates of the firm. The promotions result from GZA's continued growth and from expansion into new activities, notably environmental assessment, landfill development, hazardous waste management, and health surveys. Simon's specialty areas include applying computer analysis techniques to the evaluation of geotechnical engineering problems; he is also GZA's corporate director of data management.

Wayne D. Gass, S.M.'62, business manager at Mount Holyoke College, South Hadley, Mass., has been named to the additional post of dean of administration. Gass joined the staff in 1968 as director of physical facilities and became business manager in 1982. . . . **Myron S. Rosenberg,** Ph.D.'77, has been named an associate of Camp Dresser & McKee, Inc. (CDM), Boston. Rosenberg is described as "an authority on the theory and practice of multiple-objective decision making associated with conflict-prone management issues"; he most recently served as deputy project director of CDM's Underground Storage Tank Research Program.

Word has been received of the death in January 1987 in New Milford, Conn., of **Hugh MacDougall,** S.M.'30, a civil engineer and former United Nations official. From 1964 until his retirement in 1972, MacDougall supervised water development projects for the United Nations, most recently the establishment of a hydraulic engineering training center in Bandung, Indonesia. From 1950 to 1964 he served as vice-president and chief engineer with the Hydrotechnic Corp., New York City, directing major projects worldwide. MacDougall and late wife, Ursula (Cooke), were among the founding teachers of the Putney School in Vermont, where they taught science and engineering from 1935 to 1942. . . . Lieutenant Colonel **Robert E. Burrows,** S.M.'48, of Walla Walla, Wash., passed away on June 8, 1987; no further details are available.

II MECHANICAL ENGINEERING

M.I.T. Professor **Warren Seering** is the author of "Robotics, Numerical Control, and the Computer," a chapter in *Microelectronics, Automation, and Employment in the Automobile Industry* edited by Susumu Watanabe (John Wiley & Sons, 1987). Computer technology will become ubiquitous in the industry, Seering says, used to organize the flow of parts, to plan the operation of machine tools and assembly lines, to train workers, and to control deliveries. But these changes will not necessarily improve the working environment, he says. "Decisions on how the technology is used will be made not by computers but by people," and operators need to prepare for "active roles in the decision-making processes."

Kim Mosley's "Venture Cat" Venture

For his M.I.T. master's thesis under Professor David Gordon Wilson, Kim Mosley, '77, designed a high speed, human-powered catamaran, the "Venture Cat." Now you can buy one—from Emprise, Inc., a firm that Mosley and his wife, Cynthia, formed in 1985 in Methuen, Mass.

The lightweight "Venture Cat" is constructed of fiberglass, aluminum, and stainless steel; each 15-foot hull weighs less than 40 pounds, with a total weight for the craft of 140 pounds. The foot-pedaled boat is capable of reaching speeds of over eight miles per hour. It is driven by a computer-designed propeller that Mosley perfected while working with Professor Emeritus E. Eugene Larrabee, S.M.'48. The hulls are designed for minimum water resistance, and the craft can be fitted with either a single recumbent seat or a bench seat.



A rider aboard Kim Mosely's bench seat version of "Venture Cat."

Mosley's main objective in designing the "Venture Cat," he says, was to make "a simple, lightweight, high-performance water craft, priced for the majority" . . . a vessel that even a novice can operate. It's the first in a planned line of Emprise-built recreational products.

Mosley received his bachelor's degree in ocean engineering in 1977, then worked in the Special Vehicles and Devices Branch at the Naval Coastal Systems Center in Panama City, Fla. He returned to M.I.T. for a master's degree in mechanical engineering in 1981, thereafter becoming a design engineer for Klein Associates in Salem, N.H.

His wife and business partner is also a mechanical engineer. Together they are refining the "Venture Cat" line, redesigning the frame and enclosed gear drive for lighter weight, better performance, and lower maintenance cost.—*Valerie Kiviat* □

Poole: Economic Incentives for Airway Efficiency

The serious problems of today's air traffic control system—overloading, low controller morale, increasing numbers of "near-misses"—have a single, straightforward solution, says Robert W. Poole, Jr., '66, president of the Reason Foundation: privatization.

Poole's proposal has three elements:

☐ Divest from the Federal Aviation Administration all of its air traffic control responsibilities, assigning them instead to a nonprofit, user-owned Airways Corp.

☐ Give the nation's airports "significant autonomy" so that they can operate as free enterprises, able to assess user-fees as necessary to cover their expenses and offering "landing slots" on a supply-and-demand basis.

☐ Shift the ownership of airport control towers and landing aids from the FAA to airport operators.

"The key to solving the capacity problems of both the air traffic control system and the airports," says Poole, is to allow the operators of these systems to have "their own dedicated sources of revenue . . . (in the form of) prices charged to users.

"We are not getting full use of the airways and airport capacity that already exists," Poole writes in a Reason Foundation *Issue Paper*, nor will we in the future, unless pricing provides incentives for conserving the use of these scarce and valuable resources." Pricing has to be "in accordance with the true economic value" of the services provided, Poole insists.

COMSAT, the corporation that operates the nation's satellite communications services, is Poole's model: it holds a federal charter, but it is "a stockholder-owned corporation like any other, subject to regulation of certain communications activities by the Federal Communications Commission." In the same way, Airways Corp. and the airports should be subject to FAA safety regulation, he says. ☐

Harold W. Curtis, '50, chief production engineer at Brookfield Engineering Laboratories, Inc., Stoughton, Mass., has received a patent for circuitry that reduces the "noise" inherent in permanent-magnet synchronous motors. The immediate application is to improve the operating characteristics of motors used in Brookfield viscometers, according to Curtis.

Among *New England Monthly* magazine's "Local Heroes (31 New Englanders to be Grateful For)": M.I.T. Professor **Woodie C. Flowers,** Ph.D.'73. "In the austere environs of M.I.T.," says *New England Monthly*, "he has brought a rampant playfulness and an artist's creativity to the teaching of mechanical engineering."

III MATERIALS SCIENCE AND ENGINEERING

Fresh from receiving the prestigious Kyoto Prize in Advanced Technology (*see page MIT 51, October*, Institute Professor **Morris Cohen,** Sc.D.'36, of M.I.T. was tapped last fall for another major recognition: the Albert Easton White Distinguished Teacher Award of ASM (American Society for Metals) International. He is cited for "unrelenting devotion to the training of young minds in the continuing quest for new knowledge in metallurgy and materials science."

Diran Apelian, Sc.D.'73, professor of materials engineering at Drexel University, Philadelphia, has been named associate dean of Drexel's College of Engineering. . . . Professor **Julian Szekely** of M.I.T. returned to his native Hungary late last fall to speak to the Hungarian Academy of Sciences' Mining and Metallurgy Division; his talk, delivered in Hungarian, was on new steel processing technologies and their relevance to Hungarian conditions. . . . **Richard K. Pitler,** '49, was installed as vice-president and trustee of ASM International, last October. Pitler was affiliated with Allegheny Ludlum, Brackenridge, Penn., from 1965 to 1986, retiring as senior vice-president and technical director and general manager of the Special Materials Division. ASM also announced that **Thomas H. Courtney,** Sc.D.'64, has been named a fellow. Courtney, chairman of the Department of Materials Science at the University of Virginia, was cited for major "contributions to our understanding of microstructural control and property improvements in alloys, particularly in composites and sintering. . . ."

Paul E. Rainey, S.M.'68, director of Western Washington University's Technology Department, has been named head of California Polytechnic State University's Engineering Technology Department, San Luis Obispo, effective last August 31. . . . **Patrick Tissier,** S.M.'79, writes from Chicago that he is a system engineer at Matra Transit, Inc., currently building the automated guideway transit system at O'Hare Airport.

IV ARCHITECTURE

"I really love a sense of theatricality in architecture," says **Bonnie Roche,** M.Arch.'79, in *Progressive Architecture* (June 1987). Roche, who operates her own office in New York, was one of 32 young architects (ten years or less out of architecture school) chosen by the editors for a special issue. Her winning project: an apartment renovation in New York, to which Roche contributed kitchen and office designs that are described as "understated . . . clean yet full of depth and richness."

Navroz Dabu, S.M.'83, an architectural intern in the Design and Engineering Department of Seppala & Aho, Nashua, N.H., was one of four finalists in the 1986 Design Competition sponsored by Haworth, Inc., a systems furniture manufacturer.

Richard A. Kuehl, M.Arch.'67, is currently director of design at Robinson Green Baretta Corp., Barrington, R.I. Previously, Kuehl taught advanced architectural design at Roger Williams College, Bristol, R.I.

Vito Castaldi, '35, who taught mathematics in the Providence, R.I., school system from 1936 to 1972, passed away on September 3, 1987. Castaldi was a member of the Rhode Island and American Federation of Teachers, the Providence College and Rhode Island College Alumni Associations, and the Knights of Columbus.

V CHEMISTRY

Three rhetorical questions from **Gerald D. Laubach,** Ph.D.'50, president of Pfizer, Inc., in the fall 1987 issue of *Leaders* magazine: "Will regulators approve new products quickly enough to capture the great promise of the new biology? Will those new drugs be used by health care providers who have an increasingly short-term view of cost containment? And will industry be allowed to earn enough return on its present products to fund research on new ones?" Laubach's answer is guarded. "The policies of many governments are on a collision course with the promise of science," he writes. Disincentives to innovation are present in many current policies, and if not corrected they could have "deleterious effects" by the year 2000.

"New Devices Based on Molecular Materials" was the subject of Professor **Mark S. Wrighton** of M.I.T. in a major invited paper for the 34th general assembly of the International Union of Pure and Applied Chemistry in Boston late last fall.

Robert A. Duce, Ph.D.'64, professor of oceanography at the University of Rhode Island (URI), Kingston, and director of its Center for Atmospheric Chemistry Studies, has been appointed dean of URI's Graduate School of Oceanography and director of URI marine programs. Duce, described as a leader in international marine research, assumed the post last November 1. He succeeded the founding dean, **John A. Knauss,** '46, whose M.I.T. degree was in economics. . . . **Ronald M. Pike,** Ph.D.'53, chemistry professor at Merrimack College, North Andover, Mass., and **Dana W. Mayo,** '53, professor of chemistry at Bowdoin College, Brunswick, Me., are two-thirds of a three-man team credited with a laboratory technique called microscale organic chemistry. "Experiments conducted in the microscale lab use 100 to 1,000 times less chemicals than old methods. With the scale of experiments reduced, chemical reactions happen faster. Students can do many more experiments per laboratory session," wrote Bill Burt in the *Lawrence* (Mass.) *Eagle Tribune*.

After 15 years in the Massachusetts Senate, **John W. Olver,** Ph.D.'61, of Amherst is considered the legislature's top tax expert. He is chairman of the Taxation Committee, vice-chairman of the Energy and Transportation Committees, and a member of the Ways and Means Committee. Olver, who taught chemistry before entering politics, served as a state representative from 1969-1972.

John J. Wise, Ph.D.'65, has been promoted from manager of Mobil's Paulsboro (N.J.) Laboratory to research vice-president of Mobil Research and Development Corp. From his Princeton, N.J., office Wise will oversee all of Mobil's corporate research carried out at laboratories in Dallas, Princeton, and Paulsboro.

Stephen S. Hecht, Ph.D.'69, a recent recipient of the National Cancer Institute's Outstanding Investigator Award, has been appointed director of research at the American Health Foundation, Valhalla, N.Y. Hecht has been with the Foundation since 1973; his major research activities center around chemical carcinogenesis and the ways in which carcinogenic materials interact with DNA to begin the process of cancer development. . . . **William R. Moser,** Ph.D.'64, has been granted tenure as professor of chemical engineering at Worcester (Mass.) Polytechnic Institute. An expert in chemical catalysis, Moser spent 17 years working in private industry in the U.S. and abroad before joining the Worcester faculty in 1981.



J. H. Whitley

VI ELECTRICAL ENGINEERING AND COMPUTER SCIENCE

Judah L. Schwartz, professor of engineering science and education at M.I.T., is author of "The Algebraic Proposer," a new model-building tool that is designed to help students analyze word problems and formulate them mathematically. Its publisher, True Basic, Inc., Hanover, N.H., describes the "Proposer" as "a freeform problem-solving tool that lets users enter quantities and 'notes' on a 'scratch pad' requiring only that the user be explicit about the nature of the quantities and their units."

How to assess the benefits of a research program as many-sided as that of the Electric Power Research Institute (EPRI)? Turn to **Nilo A. Lindgren,** '48, for the past two years senior coordinator of EPRI's benefits assessment program. He's been responsible for designing and then analyzing questionnaires from 24 representative utilities reporting their use of more than 430 EPRI products—hardware, software, manuals, even systems—and workshops. Lindgren's conclusion, as reported in *Public Utilities Fortnightly*: "The human factor, the person-to-person contact, is still . . . the single most powerful factor for recognizing and applying innovation and for acceptance of change . . ."

John A. Tucker, special assistant to the head of the department at M.I.T., reports a recent visit from **Scott E. Cutler,** Ph.D.'73, vice-president for software design at Tandy Electronics, Fort Worth. Cutler was in Cambridge for student interviews at the M.I.T. Placement Office.

James H. Whitley, S.M.'54, director of program management for the Technology Group at AMP, Inc., Harrisburg, Penn., was awarded the Ragnar Holm Scientific Achievement Award by the IEEE last September. Whitley was cited particularly for work on tin as an electrical contact material; he has been with AMP since graduating from M.I.T. . . . **Paul Chorney,** Sc.D.'61, is now marketing manager of Raytheon's Microwave Tube Operation, Waltham, Mass. Chorney was most recently vice-president of marketing for M/A-COM Microwave Circuits, Inc.

VI-A Internship Program

Your correspondent has been involved with numerous campus activities this fall where he has met a number of VI-A alums. Besides those returning to interview in the Placement Office, there have been those at the National Alumni Conference held in Cambridge October 23, the kick-off for M.I.T.'s multimillion-dollar *Campaign for the future,* several departmental seminars, and the dedication of the Green Center for Physics.

Cecil H. Green, '23, was honored at a gala luncheon in the Grier Room on October 22 for his latest contribution to M.I.T. to establish the new Green Center for Physics. Past and present holders of Green Professorships were invited and included two VI-A graduates—Professors **Richard B. Adler,** Sc.D.'49, and **Frederic R. Morgenthaler.**

In his humble and folksy manner, Cecil reminisced after the luncheon about his coming to M.I.T. following two years at the University of British Columbia. He wanted to study electrical engineering, which wasn't then taught at UBC. A UBC professor of chemistry was from "Boston Tech" and suggested he might try for admission there.

At M.I.T. he was counseled by Professor **William H. Timbie,** then also VI-A director, to apply and was admitted. He enrolled in Course VI-A and worked with the "Generous Electric Co.," as he put it. It was at the Schenectady plant that he met Ida, who became his wife and lifelong philanthropic partner, following his successes with Geophysical Service, Inc., and its child Texas Instruments, Inc.

In his remarks Cecil was especially complimentary about the relationship that developed with your correspondent through the addition of Texas Instruments as a VI-A participant in May 1973. Cecil's VI-A Luncheons in Dallas each August for students and TI officials have become a tradition.

At the National Alumni Conference buffet luncheon on Friday, October 23, I had the pleasure of sitting with **John D. Chisholm,** S.M.'76, and his mother Elda, '49, who was to be honored the next day with the Harold E. Lobdell, '17, Award. VI-A alumnus **H. Dubose Montgomery** won the award in 1980.

Also talked at the luncheon with **Charles Hieken,** S.M.'52, and **Lawrence Kernan,** S.M.'78. "Chuck" Hieken served as an officer of the Boston Alumni Chapter of Eta Kappa Nu when your correspondent was president back in the late 50's.

Mentioning awards, two VI-A's were written up in *The Bridge* in connection with Eta Kappa Nu's 1986 Roger I. Wilkinson Outstanding Young EE Awards: **Lauren A. Christopher,** S.M.'82, won an honorable mention and **Steven D. Krueger,** S.M.'80, was a finalist. Lauren is at David Sarnoff Research Center, Princeton, N.J., and Steve is with Texas Instruments, Dallas.

We noted in the September issue of the *Hewlett-Packard Journal* that **Richard Chin,** S.M.'81, is co-author of an article entitled "VLSI-Based High-Performance HP Precision Architecture Computers."

Contact with other VI-A's, since last writing, has included (alphabetically): **Geoffrey J. Bunza,** S.M.'77, director of engineering, Mentor Graphics, Beaverton, Ore., was here for placement interviews; we had a wonderful time catching up over lunch and dinner the day he was here. . . . **Arthur C. Chen,** Ph.D.'66, now at General Electric, Schenectady, visited the office. . . . **Dale C. Flanders,** Ph.D.'78, was on-campus presenting a paper and stopped by; he is now affiliated with Lasertron of Burlington, Mass., and we had a great visit reminiscing about my visits to Bell Labs when "the gang" (**Steve Bates,** E.E.'76, **Ted Lyszczarz,** Ph.D.'79, **Ron Todd,** S.M.'75, et al) were housed out in Red Bank, N.J. . . . A card from **Edward C. Giaimo,** S.M.'75, tells of his presenting a lecture at Georgia Tech on radio communications; Ed is with Zetron, Inc., in Bellevue, Wash. . . . **Michael T. Howard,** S.M.'84, telephoned from Datex in California where he's employed; Datex has recently been acquired by Lotus. **Steven K. Ladd,** S.M.'81, called from Raychem, Menlo Park, Calif., to say he would be coming east in November for interviews and would look us up.

Herbert W. Mower, Sc.D.'72, of New Milford, Conn., paid us a visit; he's doing medical radiology work. . . . **Kelley Pan,** S.M.'79, dropped by and gave Lydia information on a number of VI-A alums; Kelly is with Merrill Lynch Venture Capital in New York City. . . . We had a nice visit with **Norman R. Scott,** '40, and his wife; Scott retired from the University of Michigan EE faculty last January. My current advisee, **Jonathan L. Sherred,** '88, tells me that his brother, **Mark A. Sherred,** '82, is the father of a girl born October 10, 1987. . . . **Friend L. Skinner,** '50, came by one afternoon, and we reminisced about his work with the late Professor **Samuel H. Caldwell,** '25, and his associations with Timbie, Wildes and Boehne. . . . **Stephanie L. Scheidler,** '85, and **Jeffrey B. Winner,** '85, are married; Stephanie is with CAS-Schlumberger, Palo Alto, and Jeff is with Schlumberger Technologies/ATE, San Jose.

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Kevin Stoddart, E.E.'73, came to the Placement Office and I stopped over to see him. He is with Watkins-Johnson Co. of San Jose. . . . **David F. Tuttle,** Sc.D.'48, Professor (Emeritus) at Stanford University, stopped by while visiting his son, who is an M.D. at Tufts University; Professor Tuttle attended our VI-A West Coast picnic in Palo Alto last July.

I appreciate, very much, all the correspondence and visits from VI-A alums that help me write this column. Many of you have surprised me by telling how much you look forward to reading it. It will only be as good as the information I receive, so don't hesitate to call or send me scribbled notes.—John A. Tucker, Special Assistant to the Department Head, for VI-A & Lecturer, M.I.T. Room 38-473, Cambridge, MA 02139-3931.

XI URBAN STUDIES AND PLANNING

Breaking the Impasse: Consensual Approaches to Resolving Public Dispute is the title of a new book (Basic Books, Inc., 1987, $19.95) by Professor **Lawrence Susskind,** Ph.D.'73, of M.I.T. and Jeffrey Cruikshank, senior editor at the Harvard Business School. For more than a decade Susskind and his students at M.I.T. and Harvard (where he is associate director of the Program on Negotiation at the Harvard Law School) have been studying public dispute management as an alternative to confrontation on issues such as environmental standards, regulation, waste disposal, and other technology policies. In this book summarizing these studies, Susskind and Cruikshank demonstrate how to "avoid the bitterness of 'win-lose' outcomes through negotiation," says the publisher.

Thomas Charles Woodruff, Ph.D.'74, of Norwalk, Conn., has been appointed vice-president of Mutual of America Life Insurance Co. Previously Woodruff served as executive director and president of the Commission on College Retirement, a blue-ribbon panel funded by the Carnegie Corp. of New York and the Ford, Mellon and Hewlett foundations. A former visiting professor at Cornell, Woodruff was executive director of the president's commission on pension policy during the Carter administration. . . **James A. Hester,** Ph.D.'70, has been appointed vice-president of planning and development of Pilgrim Health Care, Norwell, one of Massachusetts' largest health-maintenance organizations. Hester previously served as vice-president of planning and provider development for Harvard Community Health Plan. Hester was executive vice-president of the M.I.T. Alumni Association from 1978 to 1980. . . . **Ting Fun Yeh,** M.C.P.'86, is currently employed at the Boston Redevelopment Authority, planning for the redevelopment of Chinatown and the four-square-block adjacent "adult entertainment" zone. One of Yeh's major objectives, she says, is to give Chinatown residents a sense of more control over their neighborhood. "It takes a lot for them to feel secure," she said in a recent interview, "but I would say they are feeling encouraged." . . . **Boris Pleskovic,** Ph.D.'83, is currently a senior research fellow at M.I.T.'s Technology Development Program; he is on leave from the World Bank, where he is an economist in the Department of Europe, Middle East, and North Africa.

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XIII OCEAN ENGINEERING

Arch C. Scurlock, Ph.D.'48 (Course X), chairman of the TransTechnology Corp. of Sherman Oaks, Calif., has made a $100,000 grant to permit students in the M.I.T.-W.H.O.I. joint program to participate in collaborative research with the Bermuda Biological Station (BBS). Students will submit research proposals for evaluation by M.I.T. and BBS staff; they're likely to be "seeds of much larger research programs," thinks M.I.T. Professor **Arthur B. Baggeroer,** Sc.D.'68 (Course VI), coordinator of the program. He also welcomes Scurlock's grant because it provides support for research in its earliest—and therefore riskiest—stages when funding is hardest to find.

Rear Admiral **John S. Claman,** N.E.'69, is the new supervisor of shipbuilding at Electric Boat, Groton, Conn., where he is the Navy's top officer overseeing the construction of 15 nuclear submarines at the shipyard. Claman's previous assignment was program manager for the Attack Submarine Program Office at the Naval Sea Systems Command in Washington. He has extensive experience in ship design and logistics and has served on destroyers and submarines. . . . **Charles E. Slonim,** N.E.'52, has been elected a vice-president and a sector manager of Analysis and Technology's Washington, D.C., area operations, based in Arlington, Va. Previously Slonim served as IBM's site manager in Newport, R.I., after completing a naval career.

Vernon C. Honsinger, S.M.'62, writes, "My position is director of engineering of the Connecticut Division of McLaughlin Research Corp., a company engaged in providing engineering and technical services to the U.S. Navy and other customers." . . . From **Jon J. Bryan,** S.M.'73: "I am in my fourth year at American Institute for Research in Bedford, Mass., on a software development project for the United States Air Force. My wife, Janice, and I are living in the same home we bought 17 years ago when we came to M.I.T.!"

XIV ECONOMICS

A big new job for M.I.T. Professor **Stanley Fischer,** Ph.D.'69: he is vice-president, development economics and chief economist at the World Bank, based in Washington, D.C. Fischer, who joined the faculty in 1973, has gone on leave to take his World Bank job; the bank says it sought his expertise in monetary theory and policy, international monetary economics, exchange rate reforms, and the debt problems of developing countries.

Steven M. Shavell, Ph.D.'73, professor of law and economics in Harvard Law School, is the author of *Economic Analysis of Accident Law* (Harvard University Press, 1987, $30). Shavell's book is described as "the definitive synthesis of research to date" in the new field of accident law and its effects on people's behavior.

Charles Levenstein, Ph.D.'76, left his faculty position at the University of Connecticut, where he's been since 1976, to become a professor in the new Work Environment Department at the University of Lowell, Mass. . . . **Margaret G. Devries,** Ph.D.'46, has been named "Outstanding Washington Woman Economist" by the Washington Women Economists Association. Devries is also the author of a new book, *Balance of Payments, 1945-1986: The IMF Experience,* published by the International Monetary Fund. Meanwhile, her husband, **Barend A. Devries,** Ph.D.'51, of the World Bank reports that his book, *Remaking the World Bank* (Seven Lock Press, Cabin John, Md., 1987) is about the Bank's role in the global economy.

Michael Parry Mazur, Ph.D.'72, an economist with the Division of Regulatory Affairs at the Office of Management and Budget, Washington, D.C., passed away on January 22, 1987. Mazur taught at Yale University and Dartmouth College prior to relocating to the Washington area.

XV MANAGEMENT

Four eras characterize the development of data processing, says **John F. Rockart,** Ph.D.'68, director of the Sloan School's Center for Information Systems Research (CISR) in a special essay for the fall 1987 issue of *Leaders*: accounting, using batch processing in centralized computers; paperwork processing for day-to-day operations people; the end-user era, with microcomputers permitting each user to "do his own thing"; and now the "wired society" whose chief characteristic is interconnection. That means a new thrust toward integration—integration of many different activities within the firm, intercommunication among customers and suppliers, and industry-wide networking, wrote Rockart.

Eric C. Wilde, S.M.'83, has been appointed manager in the Management Consulting Services Department at Price Waterhouse, Boston. With the firm since 1983, Wilde has been involved in the design, development, and implementation of financial control systems, specifically for smaller businesses. . . . **John D. Rudolph,** S.M.'73, has been promoted from business manager—precision optics to vice-president—optical components at U.S. Precision Lens, Inc., Cincinnati. . . . **Randal B. Fischer,** S.M.'68, has been named vice-president—planning and administration for Amoco Production Co., Chicago. Fisher joined Amoco in 1971 and since then has had an international career, serving Amoco Far East Oil Co. in Singapore, Amoco Italia in Rome, and most recently as vice-president of finance and administration for Amoco Canada Petroleum Ltd.

Art vs. Graffiti: A Conflict in Definition





Two views of the same phenomenon: for James Prigoff, '47, graffiti is grist for his book, **Spraycan Art***; for Kenneth Lin, M.C.P. '83, it inspired a long-term program to clean subway cars.*

Welcome to the "it takes all kinds" department: while James Prigoff, '47, celebrates the spread of "spraycan art" from America to the rest of the Western world, Kenneth Lin, M.C.P.'83, celebrates his and his colleagues' success in eliminating graffiti "art" from the canvas on which it achieved its first and greatest fame—New York City subway cars.

In *Spraycan Art* (Thames and Hudson, 1987, $14.95), Prigoff and his co-author Henry Chalfant let one of the country's famous "spraycan" artists known as Phase 2 say it for them: "This thing has reached all the way around the world from Harlem to Japan. When has something else had an impact like that on every ethnic group in the entire world? . . . You don't even have to be able to talk English. All you gotta do is get a spraycan and paint something."

Prigoff, who studied management at M.I.T., is a successful consultant in the field of crisis management. But he's also a peace and political activist who has assembled what the publishers call "one of the major documentations of mural art in the United States."

Spraycan Art contains 224 examples from Manhattan, Brooklyn, the Bronx, and Queens to England, France, Germany, even Australia. Chalfant, a Stanford-trained artist, defined the field in his earlier book, *Subway Art*, and in a prize-winning television documentary. Now he has joined with Prigoff to document "an extraordinary cultural exchange" that began when visitors to the U.S. discovered how the rolling stock of the New York City Transit Authority (MTA) was being transformed "into giant mobile comic strips."

But what was a mobile comic strip to some observers was a symbol of decadence and mismanagement to others. Hence the MTA project in which Lin has been engaged since 1984. "In a graffiti-free riding environment," says Lin, "passengers no longer perceive the subways as out of control; they feel safer, and there's less littering."

Lin and his colleagues have approached their problem with both technology and strategy. New cars are finished in stainless steel, from which graffiti is more easily removed, and older cars have been refinished inside and out with polyurethane paints that are undamaged by the chemicals that can dissolve "spraycan art." And, having observed that a clean train tends to stay clean, the MTA has adopted a route-by-route, train-by-train strategy. Once a train is graffiti-free, MTA car cleaners concentrate on keeping it that way, inspecting and cleaning it at every turnaround, while other graffiti-laden trains await their turn untouched.

"Prompt graffiti removal deters vandals since their 'creations' are not eternal," says Lin. "So graffiti 'hits' are declining, and car cleaners can devote more time to mopping floors, wiping down seats, and cleaning windows. Overall effect: a spotless train." There's also a continuing materials-testing effort "in search of the perfect graffiti remover and graffiti-resistant railcar," says Lin.

By mid-1987 MTA estimated that 66 percent of its subway fleet was graffiti-free. The goal is to have all 6,300 cars clean by 1989.—*John Mattill* □

Sloan Fellows

When **Peter Viemeister,** S.M.'69, retired from his job as vice-president of the Gruman Corp. and moved to the Blue Ridge Mountains of Virginia, he began to hear tales of a $21 million treasure buried more than 150 years ago near his new home. Intrigued, he spent the first three years of his retirement researching local history and interviewing local experts. Finally, to his surprise, Viemeister decided the story might be true; the secret depends on some still-unsolved ciphers supposedly written by one Thomas J. Beale in 1822. But the ciphers have baffled treasure-hunters and cryptographers for more than a century. All this is now recorded in Viemeister's second book, *The Beale Treasure: A History of a Mystery* (Hamilton's, Bedford, Va., 1987, $19.95). Viemeister's first book was written 26 years ago—*The Lightning Book* (M.I.T. Press).

James R. Ball, S.M.'80, has been named to the new position of senior vice-president—commercial, at Vista Chemical, Houston. Ball joined the firm in 1969 and in his new post will coordinate the activities of the company's commercial business areas and continue to manage the Marketing Department. . . . **Rita O'Brien,** S.M.'77, New England Telephone vice-president—Rhode Island, was elected chairperson of the 35th Annual Brotherhood Award Dinner sponsored by the National Conference of Christians and Jews last May 7. O'Brien, a resident of Providence, is actively involved in community affairs including the United Way, the Rhode Island Port Authority, and the Rhode Island Expenditure Council. . . . Rear Admiral **David O. Smart,** S.M.'66, a member of the U.S. Naval Reserve, is now commander, Reserve Naval Construction Force, Lenexa, Kans., the reserve arm of the Navy's famed Seabees. Smart is executive vice-president for CDI Flooring and Interiors, Lenexa, and president of the Calibre Group, Kansas City.

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XVI AERONAUTICS AND ASTRONAUTICS

Martin C. Jischke, Ph.D.'68, chancellor at the University of Missouri, Rolla, has been named chairman of the national Congressional Aeronautical Advisory Committee, whose purpose is to advise Congress on NASA aeronautics programs. . . . Captain **Henry F. Lloyd,** S.M.'46 (USN Retired), writes that he is still at Flagler College, St. Augustine, Fla., as an administrator. "No plans for retirement," he says.

Francis G. Murphy, '41, a member of the Tiverton, R.I., Town Council, passed away on August 11, 1987. From 1975 until his retirement in 1983 Murphy was employed by GTE Power Source Center, Waltham, Mass. Earlier he served as a research physicist for the Naval Underwater Ordnance Station, retiring in 1975. He had served in the Army Air Corps as a weather officer in World War II, being discharged as a major and receiving the Purple Heart for injuries sustained off the coast of New Guinea. Murphy was first elected to the Tiverton Town Council in 1984 and re-elected in 1987.

XVII POLITICAL SCIENCE

Professor **Lincoln B. Bloomfield** of M.I.T. has completed CASCON III, a computer-aided system for analyzing local conflicts that can be used on IBM-compatible equipment, and demonstrations have been offered to key government agencies. The original CASCON was written at M.I.T. in the late 1960s with government support; the new modifications to increase its files (to a total of 67 cases) and simplify its use have been funded by M.I.T. Bloomfield is also co-editor (with Professor Harlan Cleveland of the University of Minnesota) of *Prospects for Peacemaking: A Citizen's Guide to Safer Nuclear Strategy* (M.I.T. Press, 1987, $15). The editors' goal is to "demystify the critical issues of war, peace, and national security, thus opening the way for informed citizen involvement." Bloomfield is the author of one chapter: "Nuclear Crisis and Human Frailty."

Dana Mead, Ph.D.'67, senior vice-president for white paper business at the International Paper Co., Inc., New York City, served as a member of the 1987 Campaign Cabinet for the United Way of Greenwich, Conn. Before joining International Paper, Mead taught at the U.S. Military Academy, West Point, and as a White House Fellow served as staff assistant to President Nixon.

XVIII MATHEMATICS

Professor **Terry Winograd,** Ph.D.'70, of the Department of Computer Science at Stanford is co-author (with Fernando Flores, president of Logonet, Inc., and chairman of Action Technologies) of *Understanding Computers and Cognition: A New Foundation for Design* (Addison-Wesley, 1987, $12.95). In a dust-jacket statement, **Mitch Kapor,** '81, founder of Lotus Development Corp., says the book is the "first to provide a grounded account about computers, language, and mind which informs the theory and practice of making computer programs that work for, not against, people."

Carl W. Steeg, Jr., Ph.D.'52, of Indianapolis, Ind., passed away while vacationing in New Jersey on June 23, 1987. Following graduation from M.I.T., Steeg assumed a full-time position at the M.I.T. Dynamic Analysis and Control Laboratory (DACL), where he directed and supervised many studies of torpedo systems, nuclear reactor controls, and analytical investigations for guided missiles. From 1956-63 Steeg served as manager, analysis and simulation, in the Controls Division at Airborne Systems Laboratory, Burlington, Mass. In 1963 he joined the ITT Laboratories, Fort Wayne, Ind., and in 1968 transferred to the Department of Electrical Engineering at Purdue University, Fort Wayne, where he spent the remainder of his professional career.

XXI HUMANITIES

Professor **David M. Epstein,** conductor of the M.I.T. Symphony Orchestra, was a great conductor in Helsinki, Finland, last fall, leading a concert of American music that opened the annual Helsinki Festival. Included in the program was Epstein's own work, "Ventures," for symphonic wind ensemble and Samuel Barber's Piano Concerto, which is one of the M.I.T. Symphony Orchestra's most successful recordings.

What used to be called the Music Section in the department at M.I.T. is now called the Music and Theater Arts Section, a change that recognizes that all the academically based performing arts groups are now administered by a single academic unit. Professor **John H. Harbison** is head of the section for 1987-88, and Professor **Marcus A. Thompson** continues as administrator of the theater arts group.

XXII NUCLEAR ENGINEERING

To the portfolio of **Robert R. "Burt" Barthelemy,** S.M.'63, technical director of the Air Force Wright Aeronautical Laboratories, add one more big project: management of the National Aerospace Plane Program. As laboratories head, Barthelemy is responsible for a development activity at Wright Patterson Air Force Base that employs 2,700 people and spends $1 billion a year on research objectives that include advanced aircraft, laser weapons, jet engines, strategic defense initiatives, and artificial intelligence. Technology development for the aerospace plane will continue for the next three years under Barthelemy's leadership, leading to a decision in 1990 on whether or not to build an experimental vehicle. In addition to his technical work, Barthelemy is a frequent lecturer and writer on innovative leadership and creativity, filling over 50 speaking engagements a year.

XXIV LINGUISTICS AND PHILOSOPHY

Ray Jackendoff, Ph.D.'69, professor of linguistics and cognitive science at Brandeis, is the author of *Consciousness and the Computational Mind* (M.I.T. Press—Bradford, 1987, $27.50). Jackendoff says the central question of the book is "one of the most fundamental issues of psychology: What makes our conscious experience the way it is?" He proposes that awareness depends on "a level of representation intermediate between the most sensation-like and the most thought-like," a result that he believes may "serve to deepen significantly the foundation of psychology."

TECHNOLOGY AND POLICY PROGRAM

Dan Saltzman, S.M.'80, is running as a candidate for the Oregon Senate from Portland, in the 1988 election. . . . **Richard Thomas,** S.M.'79, is currently with Synetics Corp. in the Communications and Information Systems Division. . . . **Jessica Stern,** S.M.'88, attended the United Nations Conference on Disarmament of Chemical and Biological Weapons held in Geneva last August. —Richard de Neufville, Chairman, Technology and Policy Program, Room 1-138, M.I.T. Cambridge, MA 02139.



Henry G. Houghton



James Donovan

Henry G. Houghton, 1905-1987: Leader of M.I.T. Meteorology

Henry G. Houghton, S.M.'27, who was a member of the M.I.T. Meteorology Department from its founding in 1941 until his retirement in 1970 and its head for 25 of those years, died on October 21 in South Dartmouth, Mass. He was 82.

Professor Houghton's academic training was in electrical engineering, in which he held a bachelor's degree from Drexel (1926) and his master's degree from M.I.T. He was introduced to meteorology at the Round Hill Field Station, Dartmouth, Mass., where he used electrical methods to study the physical properties of fog. Houghton, who began teaching in M.I.T.'s fledgling Meteorology Department when it was founded, became director of the Round Hill station acquired by M.I.T. in 1948.

As a member of the Meteorology Department Houghton continued studies of cloud physics and atmospheric radiation for another 30 years, at the same time developing M.I.T.'s first teaching programs in oceanography. He was a founder of the National Center for Atmospheric Research, Boulder, Colo., and the first chairman of the University Corporation for Atmospheric Research that operates the center; and he was at various times secretary and president of the American Meteorological Society and president of the American Geophysical Union's Meteorology Section.

Houghton's book, *Physical Meteorology*, was published by the M.I.T. Press in 1985, 15 years after he retired as head of the department.

Houghton held the Robert M. Losey Award (1940) of the Institute of Aeronautical Sciences for contributions to meteorology applied to aeronautics and in 1959 was given the Charles F. Brooks Award of the American Meteorological Society; he was an honorary member of the Royal Meteorological Society.

James Donovan, 1907-1987

James Donovan, '28, an officer of his class for 60 years following his graduation in chemical engineering, died in Cambridge on October 16 following a short illness. He was 80.

Donovan continued on the staff at the Institute for six years after graduation and then left to found Artisan Industries, a Waltham-based chemical engineering firm in which he was active throughout the rest of his life. He held the Founders Award of the American Institute of Chemical Engineers, of which he was a fellow; he was also a leader and past president of the Boston Section of AIChE, and he was a longtime member of the Massachusetts Board of Registration for Professional Engineers.

M.I.T. alumni will remember Donovan for long and varied services to his alma mater that earned him the Alumni Association's Bronze Beaver in 1970. There was never a time following its graduation that Donovan was not an officer of his class; he was its president for 22 years. He was also a loyal and effective participant in all M.I.T. fund-raising efforts. Walter J. Smith, '28, Secretary of the class, describes Donovan as "an extraordinary man by almost any measure. . . . Almost from the day he entered M.I.T. as a freshman," Smith wrote his classmates, "Donovan was a dedicated worker for the Institute and the Class of 1928."

Robert H. Bliss, 1920-1987

Robert H. Bliss, '48, formerly a member of the Alumni Association staff who more recently had taught mathematics and computers at Sunapee, N.H., High School, died in Burlington, Vt., on August 26 after a sudden illness.

Bliss joined United Shoe Machinery Corp. upon graduation from M.I.T. in mechanical engineering, continuing there until he returned to the Institute in 1975 to work with the Alumni Fund and Development Office.

Bliss served with the infantry in the European theater in World War II, receiving the Purple Heart, the Bronze Star, and the French Croix de Guerre. He studied at M.I.T. in 1957-59 to earn a master's degree in management, and he returned to school once more for a master's degree in mathematics and computers from Harvard to prepare for his retirement career as a teacher.

Albert List, 1901-1987

Albert A. List, donor with his wife Vera of M.I.T.'s List Visual Arts Center in the Wiesner Building, died on September 11, 1987 in New York City; he was 86.

List had a distinguished business career in management that began at age 14 when he left school to work in his father's grocery store. President Emeritus Jerome B. Wiesner describes him as "a unique mixture of industrialist and philosopher. His support of creative activity in medical research and the arts was prodigious," said Wiesner, "and his encouragement to the Council for the Arts at M.I.T. was important to its success."

George L. Diggs, 1898-1987

When he entered M.I.T. in 1916, George L. Diggs, '26, was one of the Institute's first minority students. He was readmitted ten years later and once again in 1984, but ill health forced his premature withdrawal in each case; so he died last fall unable to fulfill his persistent dreams of an M.I.T. degree.

When Diggs withdrew from the Class of 1926 he began a 30-year career with the Post Office; then came a second career as an electrical technician in the

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Draper Laboratory, from which he retired three years ago. Meanwhile, he had earned certificates from the two-year courses in electrical and mechanical engineering at the Lowell Institute School.

Claude F. Machen, 1910-1987

Claude F. Machen, '31, a leader of his class who had been a principal executive of the Boston Gas Co., died on October 2 in Boston; he was 77.

Machen studied electrical engineering with the class of 1931 and went on for a master's degree in that field in 1932. Four years later he joined the Boston Gas Co., rising in the next 30 years to be president and eventually to retire as chairman of the board and chief executive officer in 1972. Meanwhile, he was a stalwart supporter of his alma mater—an officer of his class throughout most of the period since graduation and active in fund raising for the Alumni Fund and the Leadership Campaign of the 1960s.

Richard W.Willard, 1930-1987

Richard W. Willard, '51, an educational consultant who had started his career in the M.I.T. Admissions Office immediately after graduating in mathematics, died suddenly on October 5 in Winchester, Mass.

Willard served as assistant to the director of admissions and later as assistant to the director of student aid between 1951 and 1965, and during much of this time he was also a graduate student in the School of Education at Harvard, from which he received master's (1955) and doctorate (1969) degrees.

Deceased

The following deaths have been reported to the Alumni Association since the *Review*'s last deadline:

Henry E. Strout, '17; September 20, 1987; Lawrence, Ks.
George W. Woodruff, '18; February 4, 1987; Atlanta, Ga.
Edmund J. MacDonald, '21; September 23, 1987; Needham, Mass.
Robert F. Miller, '21; June 4, 1987; Washington, D.C.
Edward F. Praetz, '21; February 14, 1987; Lawrence, Mass.
Everett A. Soars, '21; May 24, 1987; West Palm Beach, Fla.
Percy B. Bass, '22; September 25, 1987; Tequesta, Fla.
Harold L. Townend, '23; June 3, 1987; Buffalo, N.Y.
Thomas M. Lowe, '25; September 25, 1986; Atlanta, Ga.
William F. Morton, '25; March 27, 1987; Winchester, Mass.
Kenneth W. Proctor, '25; February 20, 1987; Jamaica Plain, Mass.
William Meehan, '26; September 16, 1987; Waban, Mass.
W(illis) Robert Dresser, '26; April 15, 1987; Trumbull, Conn.
Edward B. Stallman, '26; September 25, 1987; Chatham, N.J.
Henry B. Waterman, '26; September 4, 1987; Bowie, Md.
John M. Whitaker, '26; April 2, 1987; Huntington, N.Y.
Walter K. Johnson, '27; September 10, 1987; Jessups, Md.
Montague S. Burgess, '28; September 4, 1987; Garden City, N.Y.
James Donovan, '28; October 16, 1987; Cambridge, Mass.
Leon P. Gaucher, '28; June 26, 1987; Fishkill, N.Y.
Earl F. Bennett, '30; August 3, 1987; Pittsburgh, Penn.
Richard R. Hartwell, '30; June 15, 1987; Oak Park, Ill.
Mrs. James E. Keely, '30; August 3, 1987; Silver Spring, Md.
Hugh MacDougall, '30; January 27, 1987; New Milford, Conn.
Harvey B. Alexander, '31; June 14, 1984; Northport, Ala.
August J. Breitenstein, '31; July 10, 1987; Pittsburgh, Penn.
Claude F. Machen, '31; October 2, 1987; Melvin Village, N.H.
Myrle M. Perkins, '31; May 23, 1987; Santa Cruz, Calif.
Herbert C. Endly, '33; May 4, 1987; Johnstown, Penn.
Richard B. Smith, '33; July 29, 1986; Glenview, Ill.
Henry P. Wickham, '33; April 20, 1987; Glen Head, N.Y.
Gerald W. Farr, '35; September 8, 1987; Santa Cruz, Calif.
Lawrence C. Hall, '35; January 1987; Amherst, N.H.
Irving M. Harlow, '35; July 1987; Newark, Del.
William B. Bergen, '37; October 9, 1987; St. Michaels, Md.
Theodore E. Burke, '38; June 6, 1987; Volant, Penn.
Gordon E. Holbrook, '39; September 6, 1987; Scottsdale, Ariz.
Francis G. Murphy, '41; August 11, 1987; Tiverton, R.I.
George H. Vineyard, Jr., '41; February 21, 1987; Bellport, N.Y.
Paul C. Gomez, '42; February 21, 1987; Inglewood, Calif.
John O. Karstrom, Jr., '43; August 22, 1986; Denver, Col.
Harold J. Coughlin, '45; March 17, 1987; Lebanon, N.H.
Lucien R. Vianey, '45; November 9, 1986; Fitzwilliam, N.H.
Robert Cuccioli, '46; August 4, 1987; Plandome, N.Y.
George J. Katz, '47; June 26, 1987; Brookline, Mass.
Edward L. Brady, '48; September 20, 1987; Chevy Chase, Md.
Robert E. Burrows, '48; June 8, 1985; Walla Walla, Wash.
Charles W. Butter, '48; August 17, 1987; Salt Lake City, Ut.
Robert A. Ginivan, Jr., '48; September 13, 1987; Yarmouthport, Mass.
Robert K. Breese, '49; September 6, 1987; Los Angeles, Calif.
Murray Glauberman, '49; August 16, 1987; Akron, Ohio.
Frank J. Ughetta, '49; September 29, 1985; Tucson, Ariz.
Herbert M. Voss, '50; September 16, 1987; Mercer Island, Wash.
Roy W. Niemela, '51; March 1986; Wheaton, Md.
K(arl) Thomas Ludwig, '58; December 25, 1986; Cupertino, Calif.
John T. Petit, '58; December 29, 1986; Pasadena, Calif.
Raymond E. Gerson, '70; October 9, 1985; New York, N.Y.
Glenn W. Parker, '82; July 8, 1987; Harwich, Mass.
Kent D. Anderson, '87; October 3, 1987; Duluth, Minn.
Jeffrey W. Liebman, '88; October 2, 1987; Boston, Mass.

ALLAN J. GOTTLIEB, '67

A One-Cup-of-Coffee Solution: the Coffee's Still Warm

This being the first issue of another year, we again offer a "yearly problem" in which you are to express small integers in terms of the digits of the new year (1, 9, 8, and 8) and the arithmetic operators. The problem is formally stated in the "Problems" section, and the solution to the 1987 yearly problem is in the "Solutions" section.

Bridge problems are in short supply.

Problems

Y 1988. Form as many as possible of the integers from 1 to 100 using the digits 1, 9, 8, and 8 exactly once each and the operators +, −, × (multiplication), / (division), and exponentiation. We desire solutions containing the minimum number of operators; and, among solutions having a given number of operators, those using the digits in the order 1, 9, 8, and 8 are preferred. Parentheses may be used for grouping; they do not count as operators. A leading minus sign *does* count as an operator.

JAN 1. We next offer a bridge problem that Douglas Van Patter noticed in the 1986 summer nationals:

Dummy
♠ 5
♥ A K 8
♦ Q 9 3
♣ A K 8 6 5 3

Declarer
♠ A K 10 9 8 7 2
♥ 6
♦ J 10 8 6
♣ Q

You are in a four-spade contract and take the opening lead of ♥2 in dummy. Assuming rubber bridge with neither side vulnerable, how do you play the trumps? What if match points are being used?

JAN 2. Jim Landau asks us a *non*-computer problem. Compute the natural logarithms of the integers from 2 to 10, using pencil and paper *only* (no calculators, computers, or numeric tables), to four decimal places of accuracy.

JAN 3. The following problem, from Ahmad Khan and Rao Yelamarty, first appeared in the October 1986 issue of *IEEE Potentials*. It is possible to obtain all the integers from 1 to 40 by adding and subtracting various combinations of only four different integers. What are these four integers?

JAN 4. Our last regular problem, entitled "The 20th Anniversary Party," is from Richard Hess:
The hostess told me the youngest of her three children likes her to pose this problem, and proceeded to explain. "I normally ask guests to determine the ages of my three children, given the sum and product of their ages. Since Smith missed the problem tonight and Jones missed it at the party two years ago, I'll let you off the hook." Your response is "No need to tell me more, their ages are. . ."

Speed Department

SD 1. Our first speed problem is from Bonnie Dalzell and Jim Saklad. The "17-year cicada" (*Magicicada Septendecim*) is so-called because it spends 17 years underground before emerging as a winged adult. What survival-of-the-fittest advantage does this unusual life span offer?

SD 2. Greg Huber wants to know the next number in the sequence
10^3, 10^9, 10^{27}, 10^2, 0 . . .

Solutions

Y1987. This is the problem with respect to 1987 that is posed in Y1988 for the new year. It was solved by John Drumheller who, when a fully-in-order so-



SEND PROBLEMS, SOLUTIONS, AND COMMENTS TO ALLAN J. GOTTLIEB, '67, THE COURANT INSTITUTE, NEW YORK UNIVERSITY, 251 MERCER ST., NEW YORK, N.Y. 10012.

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lution was impossible, tried to get three digits in order, etc.

1 1^{987}
2 81 − 79
3 1 + [(9 + 7)/8]
4 91 − 87
5 (91/7) − 8
6 7 − 1^{98}
7 1^{98} × 7
8 1^{98} + 7
9 1^{97} + 8
10 (71 + 9)/8
11 1 + 9 + 8 − 7
12 (97 − 1)/8
13 91 − 78
14 (1 × 98)/7
15 1 + (98/7)
16 97 − 81
17 17 × (9 − 8)
18 89 − 71
19 19 × (8 − 7)
20 19 + 8 − 7
21 (91/7) + 8
22 —
23 9 + 8 + 7 − 1
24 (1 × 9) + 8 + 7
25 1 + 9 + 8 + 7
26 —
27 98 − 71
28 8/[(9/7) − 1]
29 —
30 —
31 —
32 —
33 —
34 19 + 8 + 7
35 91 − (8 × 7)
36 (9 − 7) × 18
37 (8 × 7) − 19
38 —
39 [8 × (7 − 1)] − 9
40 [7 × (8 − 1)] − 9
41 —
42 —
43 —
44 —
45 (9 × 7) − 18
46 (8 × 7) − 1 − 9
47 (8 × 7 × 1) − 9
48 1 − 9 + (8 × 7)
49 $7^{(18/9)}$
50 —
51 —
52 —
53 —
54 71 − 9 + 8
55 (9 × 8) − 17
56 1^9 × 8 × 7
57 1^9 + (8 × 7)
58 [7 × (8 − 1)] + 9
59 78 − 19
60 —
61 79 − 18
62 [(7 − 1) × 9] + 8
63 (81/9) × 7
64 (17 − 9) × 8
65 81 − 9 + 7
66 1 + 9 + (8 × 7)
67 —
68 87 − 19
69 (78 × 1) − 9
70 71 − 9 + 8
71 (9 − 8) × 71
72 89 − 17
73 [(1 + 9) × 8] − 7
74 [(8 + 1) × 9] − 7
75 19 + (8 × 7)
76 91 − 8 + 7
77 (19 − 8) × 7
78 (87 × 1) − 9
79 97 − 18
80 1^8 + 79
81 98 − 17
82 (1 × 89) − 7
83 81 + 9 − 7
84 —
85 —
86 87 − 1^9
87 1^9 × 87
88 1^9 + 87
89 17 + (9 × 8)
90 1 + 97 − 8
91 (1 × 98) − 7
92 1 + 98 − 7
93 —
94 —
95 87 − 1 + 9
96 (1 × 9) + 87
97 19 + 78
98 1^7 × 98
99 (18 − 7) × 9
100 —

Also solved by Allen Tracht, A. Holt, Naomi Markovitz, Mark Johnson, Greg Spradlin, Raymond Kinsley, Steve Feldman, Avi Ornstein, Harry Zaremba, and Alan Foonberg.

A/S 1. How can West make a contract of 6 hearts against any defense?

	♠ J 9 5 3 ♥ J 8 2 ♦ 3 ♣ A J 8 6 4	
♠ A K 2 ♥ A K Q 10 9 7 ♦ A K 7 4 ♣ —		♠ Q 10 6 ♥ 6 5 3 ♦ J 6 5 2 ♣ K Q 7
	♠ 8 7 4 ♥ 4 ♦ Q 10 9 8 ♣ 10 9 5 3 2	

The following solution is from Edgar Rose:
If North leads ♣A, draw trumps, and using ♠Q as entry, discard the closed hand's losing diamonds on the two high clubs in dummy. This will provide declarer with an over-trick. With any other lead, win in hand playing low from dummy and play all trumps, discarding low diamonds and a low club from dummy. Next play remaining high cards from the closed hand except ♠A, always playing low from dummy. At this point the closed hand has ♠A, ♠2, and two low diamonds. North has black suit cards only. Dummy has ♠Q, ♠10, ♣Q, and ♣K. Declarer now leads the ♠2, finessing from the ♠J. Dummy wins as cheaply as possible, thus establishing the remaining spade as a high card. Next, dummy leads the ♣Q, discarding the ♠A in the closed hand! North's ♣A can win one trick, but dummy will win any return.

Timothy Maloney and Neil Cohen remark that Charles Goren made essentially the same contract 50 years ago.

Also solved by Alan Berger, Arthur Cowen, Bill Huntington, Bowman Cutter, Douglas Van Patter, Dudley Church, Eric Youngdale, Garabed Zartarian, Kenneth Bernstein, Mark Foster, Michael Fu, Richard Hess, Robert Bart, Robert Briselli, Robert Lax, Tom Harriman, William Strauss, Winslow Hartford, and the proposer, Warren Himmelberger.

A/S 2. Is it true that every prime will divide evenly into at least one member of the following sequence: 10, 110, 1110, 11110, . . .?

The following solution is from Kenneth Bernstein: That statement is correct. Using the notation (a)(b) to denote the decimal integer formed by writing a 1's followed by b 0's. The given sequence consists of the numbers (n)(1) for n = 1,2, . . . Obviously 2 and 5 divide every number in the sequence. Let p be prime, $p \neq 2$ or 5, and consider the p + 1 numbers (m)(1)m = 1,2, . . ., p + 1. Two of these numbers must be equal modulo p. Denote them by (n)(1) and (n')(1) with n' > n. Their difference, (n' − n)(n + 1) = 10^n(n' − n)(1), is then divisible by p. But p does not divide 10^n. Thus p divides(n' − n)(1).

Also solved by Bill Huntington, Charles Sutton, Dennis White, Edward Dawson, Neil Cohen Harry Zaremba, Richard Hess, Robert Bart, Scott Berkenblit, Steven Feldman, Tom Harriman, and Winslow Hartford.

A/S 3. Show that, using only the operations of addition, subtraction, and multiplication, any three integers can combine to produce a multiple of 12.

The following solution is from Edward Dawson: Let the integers be represented by L, M, and N. For each of them a congruence can be written as follows: L ≡ l(MOD 12), M ≡ m(MOD 12), N ≡ n(MOD 12), where 1, m, and n can have values of 0, ∓1, ∓2, ∓3, ∓4, ∓5. When l, m, and n are unequal, one of the operation sequences in the following table will yield a multiple of 12. When the same operations are performed on the corresponding values L, M, and N, the resulting integer will also be a multiple of 12.

l	m	n	Operations	Result
1	2	3	1 + 2 − 3	0
1	2	4	(1 + 2) 4	12
1	2	5	(1 + 5) 2	12
1	3	4	1 + 3 − 4	0
1	3	5	(5 − 1) 3	12
1	4	5	1 + 4 − 5	0
2	3	4	(2) (3) (4)	24
2	3	5	2 + 3 − 5	0
2	4	5	(5 − 2) 4	12
3	4	5	3 + 4 + 5	12

Similar operations on mixtures of positive and negative values of l, m, and n, will also provide multiples of 12. When any two, or all three, values of l, m, and n are equal, a computation of the form (l − m)n, where l = m, will give a result of zero, so that (L − M)N will be a multiple of 12. If l, m, or n is zero, the product (L)(M)(N) is a multiple of 12.

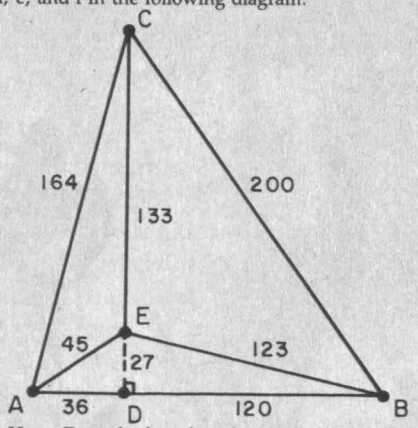
Also solved by Bill Huntington, Harry Zaremba, Richard Hess, Robert Bart, Steven Feldman, William Strauss, Winslow Hartford, and the proposer, Michael Gennert.

A/S 4. A fly is sitting on the positive x-axis a distance h from the origin. A man with a fly swatter is sitting at the origin and spies the fly. At t = 0 the fly is pursued by the man, who has a maximum acceleration of unity. The fly evades the swatter by flying out along the x-axis with an acceleration 0.6t. What is the largest initial separation h for which the swatter can intercept the fly in a finite (positive) time? Tom Kelley felt that this problem, which he classifies as "a simple one-cup-of-coffee problem," made his day.

His solution is:
$a(fly) = 0.6 \times t$
$v(fly) = 0.3 \times t^2$ (initial $v = 0$)
$d(fly) = 0.1 \times t^3 + h$ (h = initial separation)
$a(man) = 1$ (max.)
$v(man) = t$ (max., initial $v = 0$)
$d(man) = 0.5 \times t^2$ (max., initial $d = 0$)
Note 1: Use maximum acceleration to catch fly at largest initial separation.
Note 2: Man and fly have the same velocity at $t = 0$ (both at rest) and $t = 10/3$ ($v = 10/3$). Between $t = 0$ and $t = 10/3$ the man is moving faster than (catching up to) the fly; after $t = 10/3$ the fly is moving faster and the man can never catch it.
Note 3: At $t = 10/3$, $d(man) = 0.5 \times (10/3)^2 = 0.5 \times 100/9 = 50/9 = 150/27$, and $d(fly) = 0.1 \times (10/3)^3 + h = 0.1 \times (1000/27) + h = (100/27) + h$. Equating the two (splat!): $h = 50/27$. Coffee's still warm.

Also solved by Antony Merz, Bill Huntington, David DeLeeuw, Dennis White, Duncan Allen, Edward Dawson, Harry Zaremba, John Rulnick, Kelly Woods, Ken Rosato, Kenneth Bernstein, Mark Foster, Michael Auerbach, Michael Jung, Peter Silverberg, Ray Kinsley, Richard Hess, Richard Marks, Robert Bart, Robert Moeser, Ruben Cohen, Scott Berkenblit, Steven Feldman, Tom Harriman, Winslow Hartford, and the proposer, John Prussing.

A/S 5. Find integral values for the lengths a, b, c, d, e, and f in the following diagram.



Harry Zaremba found a solution that depends on two assumptions:
It is assumed all the lengths are to be unequal, and that the extension of line $CE = e$ is perpendicular to the line $AB = c$ at the point D.
One solution involving Pythagorean triplets is indicated in the figure in which the required integral lengths are:

$AC = a = 164$	$AE = d = 45$
$BC = b = 200$	$BE = f = 123$
$AB = c = 156$	$CE = e = 133$

Also solved by Avi Ornstein, Bill Huntington, Dudley Church, Edward Dawson, Garabed Zartarian, Joe Neuendorfer, Ken Rosato, Mark Foster, Mary Lindenberg, Robert Bart, Scott Berkenblit, Tom Harriman, Yamaji, William Strauss, and Winslow Hartford.

Better Late Than Never

APR 1. Robert Bart does not consider the solution "an entirely different approach."

APR 2. Unfortunately, either I misplaced Robert Bart's solution or it was lost in transit. Mr. Bart had recognized that **APR 2** is the famous "Problem of Apollonius," which admits eight exact solutions. Stanley Zisk also found eight solutions and writes: One way to describe the eight solutions would be as follows. With your numbers 1, 2, and 3 as the original circles, imagine a circle "0" drawn through their centers. Then let us define that a solution circle "contains" one of the original circles when its tangent point lies outside the circle "0." Now we see that your number 4 is the solution that "contains" none of the originals; number 5 contains all three of the originals; and numbers 6, 7, and 8 each contain two of the originals. It is easy to see that there are three more circles that each contain only one of the originals. This definition for "contain" will not always be strictly accurate for all combinations of sizes and arrangements. Another way to describe the solutions would be to start with the inscribed circle, number 4. Keeping it tangent to numbers 1 and 2, allow it to enlarge and intersect with number 3. Continue to enlarge it until it has entirely swallowed and is again tangent to number 3, on the other side. This could also be done for numbers 1 and 2, yielding a total of three new solutions. Now going back to the first of the new solutions, keeping it tangent to number 2 (on the outside) and to number 3, allow it to enlarge and intersect number 1 until it is again tangent to number 1 on the outside. This results in your number 8, and so forth. So, I suggest that the general number of solutions is, in fact, eight: three each containing one and two circles, and one each containing zero and all three circles.

APR 5. William Strauss found an alternative solution that he believes is easier to do in your head.

M/J 1, M/J 4. Tom Harriman has responded.

JUL 2. Naomi Markovitz and Tom Harriman have responded.

JUL 3. Michael Jung, Dave McNally, Tom Harriman, and Alan Taylor have responded.

JUL 4. Naomi Markovitz, Tom Harriman, and Norman Wickstrand have responded.

JUL 5. Michael Jung and Tom Harriman have responded.

A/S SD1. Dudley Church notes that it takes training to tie a bowline with one hand.

Proposers' Solutions to Speed Problems

SD 1. All predators of the cicada must have a generation length that is relatively prime to the cicada's. Hence if the predator has a population increase due to a good supply of cicadas, the next swarm of cicadas will emerge out of sync with the predators, reproductive cycle. (If the predator has a one-year cycle it will need to wait 16 generations for cicadas, and no predators have life spans of 34, 51, etc., years.)

SD 2. The ith term of the sequence is the smallest non-negative integer whose name contains the ith letter of the alphabet, i.e., thousAnd, Billion, oCtillion, . . .

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Of Counsel
Alfred R. Johnson, '35



DONORS' PROFILE:

MR. AND MRS. MILLARD M. GREER

HOME: North Palm Beach, Florida and Madison, Connecticut

CAREER: Mr. Greer, who earned an MIT degree in metallurgy in 1926, is a former vice president of engineering for the Edwin L. Wiegand Company in Pittsburgh, a firm that manufactures industrial and commercial heating equipment. After 22 years with the Wiegand Company, he co-founded Dittman and Greer, Inc., a heating supply company in Middletown, Connecticut.

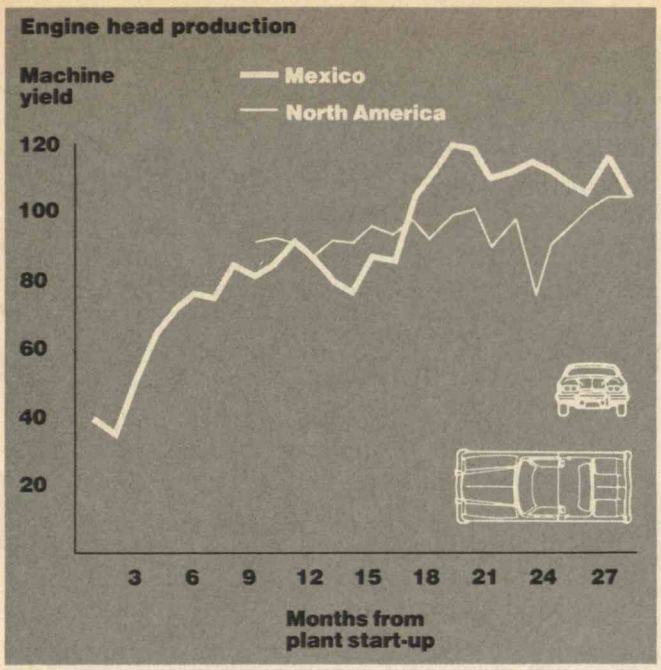
Mr. Greer was captain of MIT's crew team during its unbeaten season of 1926. (He joyfully recalls the team's triumphs over Harvard, Princeton, and Yale.) Mrs. Greer, a graduate of Columbia University, is an avid golfer and is active in golfing organizations.

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Photo: Stu Rosner



Mexican high-tech production of two important engine components was comparable to that of North American plants. The Mexican plant took longer to get up to speed on the notoriously difficult crankshaft line. The machine yield shown is a percentage of average North American production in 1985.

they imported with an equal value of exports. It was partly to satisfy these new export quotas that Universal opted to open its engine plant in Verde. (The other five multinational automakers at work in Mexico also invested in high-volume engine plants, providing an export capacity of over 1.5 million engines in 1987.)

Another powerful incentive for choosing Mexico was the country's low hourly wage rate—less than $1.50 including benefits, compared with $25 in the United States. It's sometimes thought that such cost-cutting produces negligible results in factories that rely on sophisticated automation and fewer employees. But fewer workers doesn't mean none, and hourly labor can account for 20 percent of the value added in a high-tech U.S. engine plant. Cutting production costs, however, requires not simply cheap labor but also skilled workers to keep the costly machinery running—a tough challenge for industry moving offshore.

While the Mexican government discouraged Universal from building the plant in the heavily congested Mexico City area, the company ruled out the U.S. border area because a number of low-tech assembly plants already at work there threatened to compete for workers. Verde seemed the best choice since it was close enough to the border for easy shipping to the United States. It lacked the small shops surrounding American and Canadian auto plants that make and repair tools as they break in the normal course of engine production. But Universal planned to set up an area where computer-controlled machine tools would allow novice workers to produce sophisticated parts. As for the workforce itself, Universal had bright hopes. The region's employees were strangers to unions, had a reputation for being eager and industrious, and were well-educated, many having had some years of schooling at the local technical college.

Football Fields of High Tech

Acres of densely packed machinery confront a visitor to the Verde plant. Coolant mists the air over rapidly turning cutters, and the clang of parts as they're whisked down the line drowns out conversation. It's vain to look here for individual workers at each machine. Mechanical linkages and sophisticated electronics, including the latest computer controls, guide parts through production. Managers here point with pride to features that don't commonly exist in U.S. engine plants—for instance, the crankshaft line where lasers guide tools for precision drilling, and where a computer automatically prints out quality checks.

The plant is divided into two parts: a labor-intensive assembly line and four capital-intensive machining areas. The latter areas, called "transfer lines," constitute the heart of the plant where raw castings are shaped into major, tight-tolerance engine parts. Each transfer line can be as big as a football field, and costs between $10 and $20 million. Developed in the early 1950s, transfer-line technology brings dozens of specialized machine tools together in the automated craft of engine building. Steel arms transfer the rough forms of finished parts from one huge tool to the next as parts are automatically clamped, then cut, drilled, ground, or honed to tolerances as exacting as two ten-thousandths of an inch—10 to 15 times smaller than a human hair.

An automated guided vehicle system feeds the transfer lines. Following wires embedded in the floor, a driverless cart transports baskets of parts from a cavernous warehouse—also automated—to the start of the machining lines, then returns empty baskets to the warehouse for reloading.

Hard decisions lie behind the plant's impressive machinery. Universal's planners had to choose between adopting the most advanced technologies worldwide or downscaling the plant, as tradition would have required, to accommodate the lesser skills of the workforce and the less-developed infrastructure. They knew that going high tech would mean tougher training requirements and more com-

DIAGRAMS: TOM BRIGGS DESIGN

The spectre of Japanese competition loomed in the minds of Universal executives.

plicated operations once the plant was running.

But the specter of Japanese competition loomed in the minds of Universal executives, who commonly refer to the period of decisions about the plant and its equipment as the "after Japan" period. Many operating methods at Verde emulate those of the Japanese, and so does the corporation's standard for measuring labor productivity. "Engines per man" was a concept first used by Japan, and the company adopted it to facilitate comparison with their arch-competitors, aiming over the long haul to double an engine-to-worker ratio that was lean from the start.

"The plant was our first shot out of the barrel after learning [from international competition] that we were deficient," says one division manager. He boasts that Verde represents Universal's "latest state of the art," outshining corresponding ones in the U.S., and he calls the plant "world class." (Indeed, Verde's management reports directly to Detroit rather than to Universal's subsidiary in Mexico City.)

Reasons beyond the race with Japan, however, prompted the decision to go high tech. For one thing, engine plants have long lives. In low-tech machinery executives foresaw locking in low productivity for a decade or more. They also reasoned that the break-neck speeds Universal aimed to attain dictated automated transfer of parts. Moving engine blocks by hand between machines every 24 seconds, for example, would virtually guarantee costly damage to high-tolerance surfaces.

Still another reason to adopt super-automation lay in Universal's desire to control the work pace. Operators who load and unload machines can control or "peg" production rates. "We spent a lot of money on automatic loading," commented the plant manager, "to avoid operator pegging." Finally, Universal felt the Verde plant was ideal for testing advanced equipment since the workforce had neither a bias against automation nor any preconceived notions about its use.

Quick Skills for the Unskilled

"World class" in human terms means maintaining a lean workforce. In high-tech plants like Verde, operators oversee 50 to 100 feet of machinery, some of it over a story tall. A mere 16 people oversee the computer-controlled cylinder-block line, whose speed is meant to turn out blocks at the staggering rate of 150 an hour.

Experience and feel govern the work here, as operators inspect parts, unjam conveyors, change dozens of tools, and make continuous adjustments to keep the machinery running smoothly. An experienced U.S. operator can hear a cutter squeal 20 feet away over the din of the factory and know it must be changed immediately, since a minute's delay may mean that three blocks have to be scrapped.

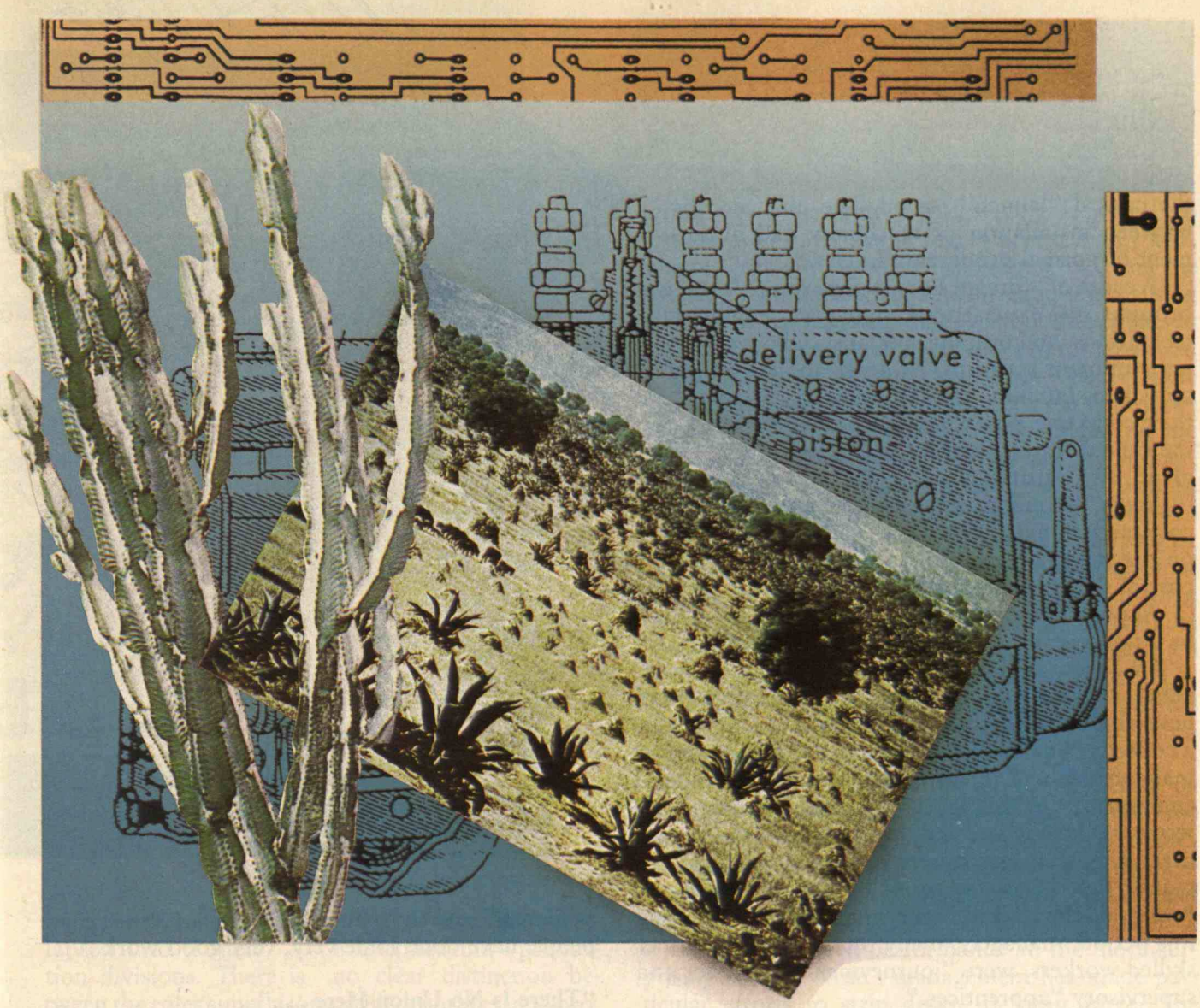
Even more critical are the skills of repairers, who must troubleshoot and fix complex electronic, hydraulic, and mechanical systems as production continues around them. The toughest problems are the subtlest. A machine is running, for instance, but the part that it is turning out doesn't quite pass muster. The worker must then track down the minor machine flaw responsible for a waver in the micro-finish, or some infinitesimal size discrepancy in a part that could fail 10,000 miles down the road, creating major engine problems.

In the United States, extensive training and apprenticeships under senior workers transform novices into workers with the diagnostic and repair abilities essential to the high-tech lines. Universal could have partly recreated such relationships in Mexico by starting with a small core of veteran workers to help break in the Verde trainees. But the company's executives feared that skilled workers would bring traditional attitudes and work practices into the plant, and the company wanted to avoid this at all costs. What it wanted above all in its new workforce was flexibility. Its training manual expressed this desire clearly, explaining that transfers from Universal's Mexico City plant were vetoed ". . . to avoid inflated wages/benefits and old work practices."

Shop-floor flexibility was purchased at the cost of inexperience. Without veteran workers to help teach the fledgling employees, Universal had a monumental training problem on its hands. Compounding this difficulty was the fact that management was collapsing the seven or so basic trades traditional in U.S. plants into two—electrical and mechanical. This meant that a mechanical repair worker at Verde had to master not only machine repair but hydraulics, pipe fitting, rigging, and welding as well.

Managers into Journeymen

Verde's managers sought to offset the lack of ex-



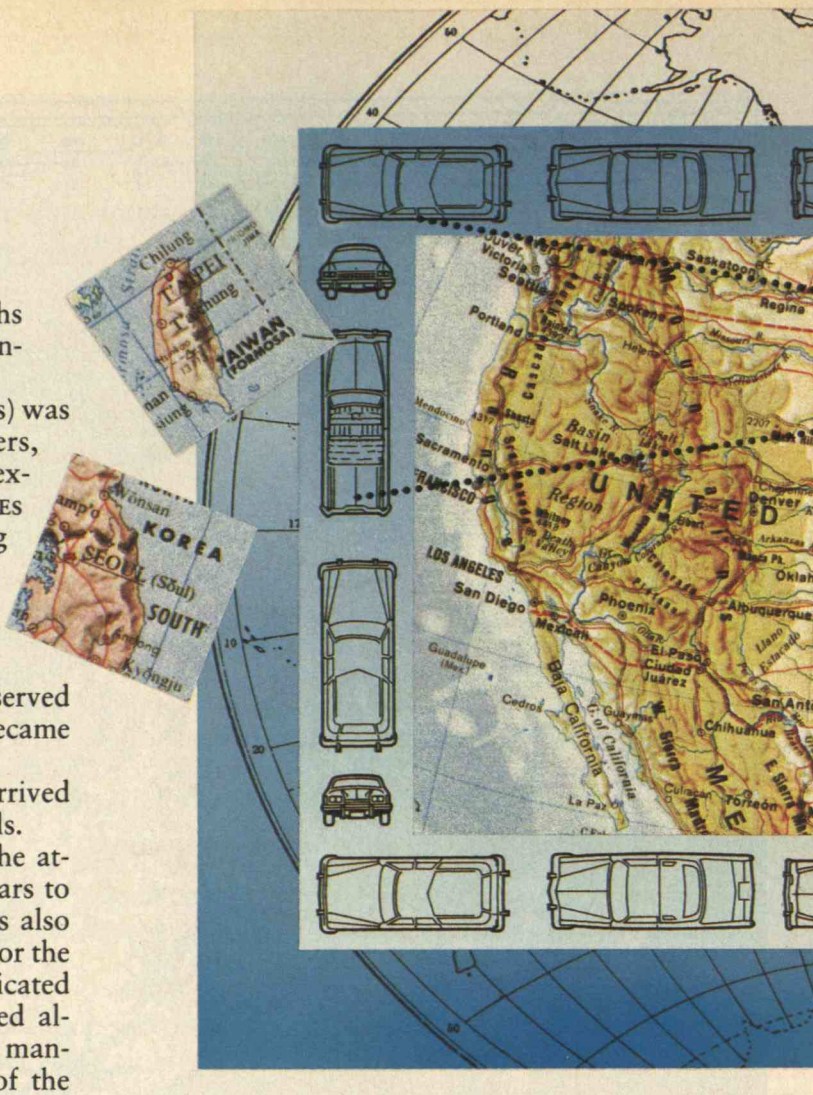
perience in their workforce by hiring highly motivated and well-educated workers. It had no trouble finding them. Mexico is in bad economic straits, and jobs at the plant seemed very attractive to workers confronting high unemployment. Some 3,000 people applied for the 250 production jobs Universal needed for start-up, and 1,500 applied for 125 skilled jobs.

The heart of the training programs for skilled workers entailed six months of intensive instruction at the local technical college. The training began with classes in blueprint reading, machine controls, and electrical and mechanical systems. The trainees then spent five weeks tearing down and rebuilding an old section of production machinery central to the operation of the plant. A quarter of the new hires spent several months with machine-tool suppliers in the United States becoming familiar with the automated tools to be installed at the new plant.

To anyone familiar with the training of skilled workers at Universal's North American plants, this is remarkably short. Apprentices spend four years working closely with skilled journeymen, picking up the countless tricks of the trade. Good diagnosis, the heart of the craft, depends on experience as well as ability. When a machine whines ominously on the plant floor, the worker may remember he had solved a similar problem by removing a metal chip from a valve—a quick repair—rather than try to rebuild a hydraulic pump, a difficult repair that could tie up production for a day. U.S. workers also undergo several hundred hours of classroom instruction, and after their apprenticeship are paired with more experienced workers for several more years.

To compensate for their Mexican workers' truncated training, Universal moved decision making upward in the Verde plant to a special corps of managers. These people were responsible for making the operating and maintenance decisions made in the U.S. by operators, skilled workers, and supervisors.

Three groups were key in providing expertise for



the critical "launch" period—the nine months between installation of machinery and attainment of normal production levels:

☐ A cadre of "foreign service employees" (FSEs) was brought in—experienced managers, engineers, technicians, and training specialists who were experts in plant start-ups. At peak, about 60 FSEs and their families lived in Mexico, bringing their collective experience from operations in the United States, Canada, Brazil, Spain, England, and Australia.

☐ Some 40 managers, engineers, and accountants from Universal's Mexico City plant served on the launch team. Unlike the FSEs, they became part of the permanent Verde workforce.

☐ About 80 technicians, many European, arrived to work on machine tools at different intervals.

If we view skill and experience simply as the attributes of individual workers, the plant appears to have run with minimal skill levels. But skill is also a collective phenomenon that remains critical for the maintenance and repair of the plant's sophisticated equipment. On this level, Universal discovered alternatives into where skill can be exercised. A manufacturing manager observed that in much of the plant's first several years of operation, "problems [were] all elevated to higher management." During this period, managers, many of whom were former skilled workers, were "journeymen" to worker and supervisory "apprentices."

In their metamorphosis into journeymen, the managers naturally encountered problems. "Sometimes we go to meetings," said one block-line manager, "and when we come back, the line is stopped. At [Universal's Canadian plant] the operator would change a bushing or a drill, but here someone else has to make the decision."

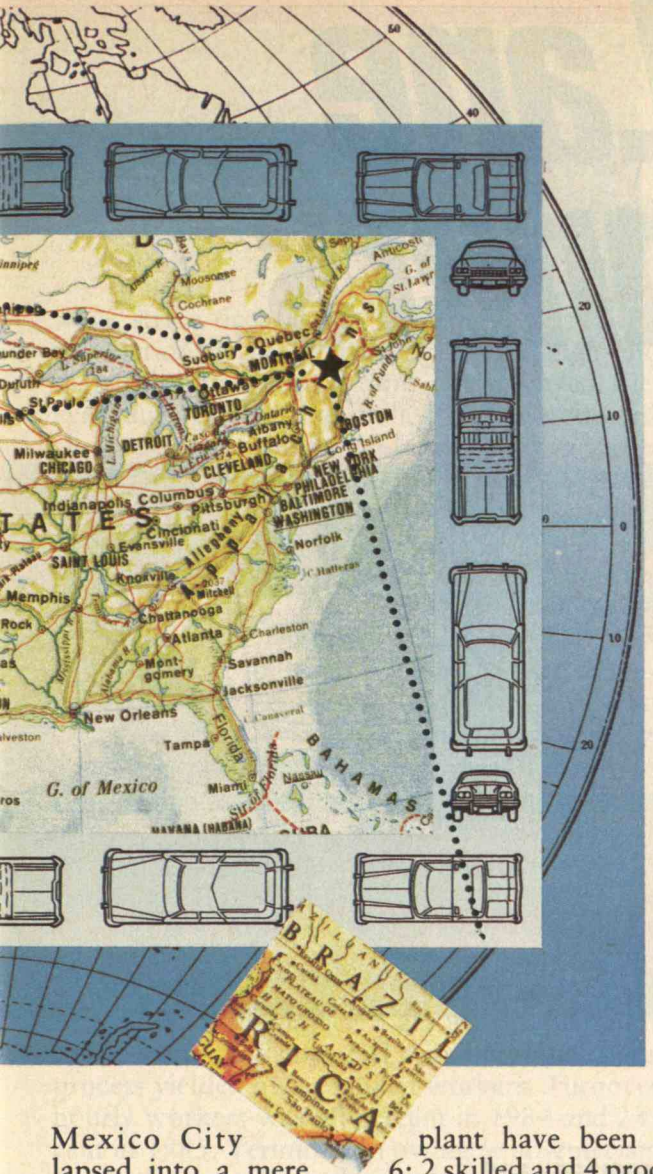
But even while the diversion of routine shop-floor decisions to management has sometimes slowed down production, Verde's managers seem confident that over time the plant's workers will become comfortable with high-volume automated production. "As the experience level builds," said one manager, "the level of decision making will come down." In fact, by March 1984—one year after the plant started up—the original 60 FSEs had dwindled to 38, while by December 1985 only 9 remained, with 1 on the shop floor. Verde's managers felt the Mexican workers had met the challenge. "Some of the repairs we've done on the machines out there are really phenomenal," said the manufacturing manager. "These people have done some very, very good work."

"There Is No Union Here . . ."

The labor contract governing Verde's unusual management-worker relations was drawn up with the Confederacion de Trabajadores Mexicanos (CTM), Mexico's largest labor confederation and a pillar of the nation's governing party. The result of informal and formal negotiations was a contract managers in the United States may dream about but seldom get—one that guaranteed them a virtually free hand on the shop floor. The contract gave the union jurisdiction over wages and benefits alone, conferring almost no shop-floor rights. "As far as I'm concerned," said a North American block-line manager of the final contract, "there is no union here."

The work week—40 hours in the company's Mexico City plant—was extended to 45. Wages were slashed to half of what Universal pays in older Mexican operations and benefits were cut to a third, although both remain in the top third for the state.

The 150 production classifications in Universal's



Mexico City plant have been collapsed into a mere 6: 2 skilled and 4 production divisions. There is no clear distinction between the roles supervisors, skilled workers, and production workers play when machines break down. Everyone is expected to pitch in. Seniority has largely been scrapped as a promotion criterion and replaced by managerial assessments of merit. Says one plant manager, because the workers have "no previous connection with unions or the automobile industry [we can] approach the Japanese way instantaneously."

Competitive Against the Odds

Verde proved impressive when we compared its performance with that of the U.S. plant producing the same engine and a modern Universal plant in Canada. Our yardstick was machine uptime—or the actual production ("yields") achieved by the plant for various engine parts. Uptime is at a premium in high tech. Because breakneck production speeds virtually guarantee periodic collapses, actual machine yields waver between 60 and 70 percent of what is theoretically possible. Thus a line moving at a speed to produce 150 parts will in reality produce only 105. The tensions produced by production loss, and the specter of millions of dollars of equipment sitting idle during repair, mean that every minute counts in high-tech production in a way it doesn't in low tech.

We found that the Mexican plant's "yields" were at least respectable—and in one case even superior—to those of the U.S. and Canadian plants on the crankshaft, cylinder-block, camshaft, and cylinder-head lines. (*See the charts on pages 40-41.*) Even the lowest percentages achieved by the Verde plant—71 percent of U.S. yields on the crankshaft line and 61 on the cam line—may overstate the difference, since the U.S. figures seem unusually high. (The Canadian plant's yields are more typical.) These machining lines contain equipment that is more sophisticated than that of the other lines, and they are notoriously difficult for any workforce to maintain. (In fact, the West German technicians often had problems maintaining the new equipment.)

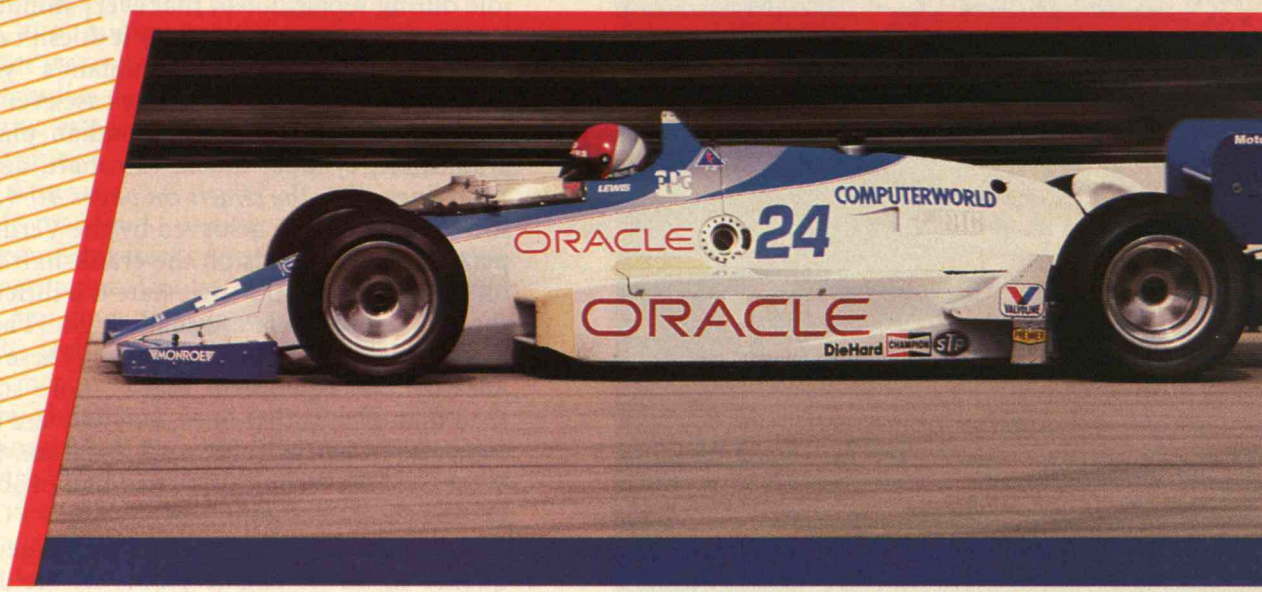
The company has put unprecedented stress on quality in all its engine plants in the 1980s. One important measure of quality is repairs per hundred, an indicator of an engine's reliability. By this measure Mexico has quality levels between the U.S. and Canadian plants.

What makes such performance all the more surprising is that Verde's management has made particular efforts to strip down its labor force. The remarkable performance of the block line (producing 94 percent as much as the U.S. block line) was achieved by a mere 16 workers, by contrast with the 25 who work on the U.S. line. The company plans to strip down its Mexican workforce even further, doubling the ratio of engines produced to workers by 1990. This seems curious given that little money would be lost if current staffing levels were maintained or even increased, since the plant would see less downtime and wages are low. Yet Universal remains obsessed with Japan and stubbornly clings to the Japanese measurement "engines per man," interpreting it literally to mean fewer of the latter to produce more of the former.

Labor Problems Ahead?

All is not rosy at Verde, and some of the problems the plant has had may well be due to the tight clamps Universal has put on the workforce. A five-week

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The Verde plant, already competitive with its U.S. counterpart, could exceed its output within two years.

wage strike occurred in January 1983, just before production began. According to one high-ranking manager, the company and union stayed friendly even during the strike. Still, the disastrous slide of the Mexican economy could ultimately affect labor relations at the plant. Both hourly and salaried workers feel their living standards are deteriorating, and they are deeply concerned about the future. "Most of the people are suffering a lot because of the inflation problem," said one Mexican manager. "Sometimes their mind is not on the floor, it is on their outside problems. We need to give the people the right amount of money, not to be rich but to survive. We are every day going down."

Low wages and long hours for an ambitious and eager workforce may result in short terms of service, as those who are trained move up to what they consider better jobs, and those discouraged by lack of rapid advancement move on to jobs that pay better or are less strenuous than those at Verde.

In fact, workforce "churning"—created by workers who leave the company or are promoted—has become a leading concern among production managers, some of whom feel that the initial selection process yielded overqualified workers. Turnover for hourly workers was 30 percent in 1984 and 23 percent in 1985. Termination owing to absenteeism accounted for over a third of the 1985 turnover. Absenteeism and a refusal to work overtime were largely concentrated among production workers, especially assemblers, whose work is the most demanding. (Such problems may also reflect their youth. "These workers work to live, not the opposite," commented one manager.) Turnover among salaried workers was 17 percent for 1985 (about half left for better jobs in another company). While this rate declined to 7 percent through August 1986, the plant's industrial-relations manager foresees other departures as more multinationals locate in the area.

Another problem at Verde is the absence of the small tool shops surrounding U.S. and Canadian plants. These firms make and repair tools vital for engine production. Universal's substitute—a computerized tool room that accommodates novice workers—is a compromise. Moreover, the plant must carry high inventories of spare parts and continues importing many precision components from the United States for assembly, making for long supply lines.

Despite these problems the consensus at Universal is that the plant, already competitive with its U.S. counterpart, could exceed the latter's output within two years at least and a decade at most. Plant managers think that their leading problems—workforce inexperience and a shaky industrial infrastructure—will improve in time.

Verde has indeed performed remarkably in the most difficult of circumstances, where an extremely sophisticated production process for making the most complicated parts of an automobile was wedded to inexperience and a fragile infrastructure.

If high tech can work here, it's easy to envision the ease with which it could be established in less-complicated circumstances. And indeed, evidence suggests that the ties are steadily eroding between high-tech production and developed economies. South Korea alone built more than 600,000 cars in 1986, up from 83,000 in 1977. GM plans this year to start importing 75,000 Pontiac Le Mans annually, and Ford will import an equal number of Festivas—both from joint ventures with Korean firms. Because it's far easier to expand capacity than to start new plants, South Korea could produce more than 2.5 million cars a year by 1990.

At home both the Democratic and Republican parties, spurred by a 1986 report by the president's Commission on Competitiveness, have adopted the common notion that high technology will keep America in the world economy. This notion is sure to figure prominently in trade debates during next year's election race.

High tech will compete by staying at home, so the thinking goes. Yet some of America's yawning trade deficits already owe to the flight of corporations to the Third World. Consider the disproportionate responsibility of U.S. multinationals for the $15 billion trade deficit with Taiwan and the $7 billion deficit with South Korea.

The trade debate has largely and shortsightedly focused on gaining market access abroad while ignoring the significance of where production takes place. Clearly, newly industrializing countries have a pressing need for employment and development as well as investment policies that encourage them. Yet if the United States lacks trade policies that guarantee production and employment at home, "competitiveness" alone could mean that individual firms succeed while the U.S. industrial base and economy erode. □

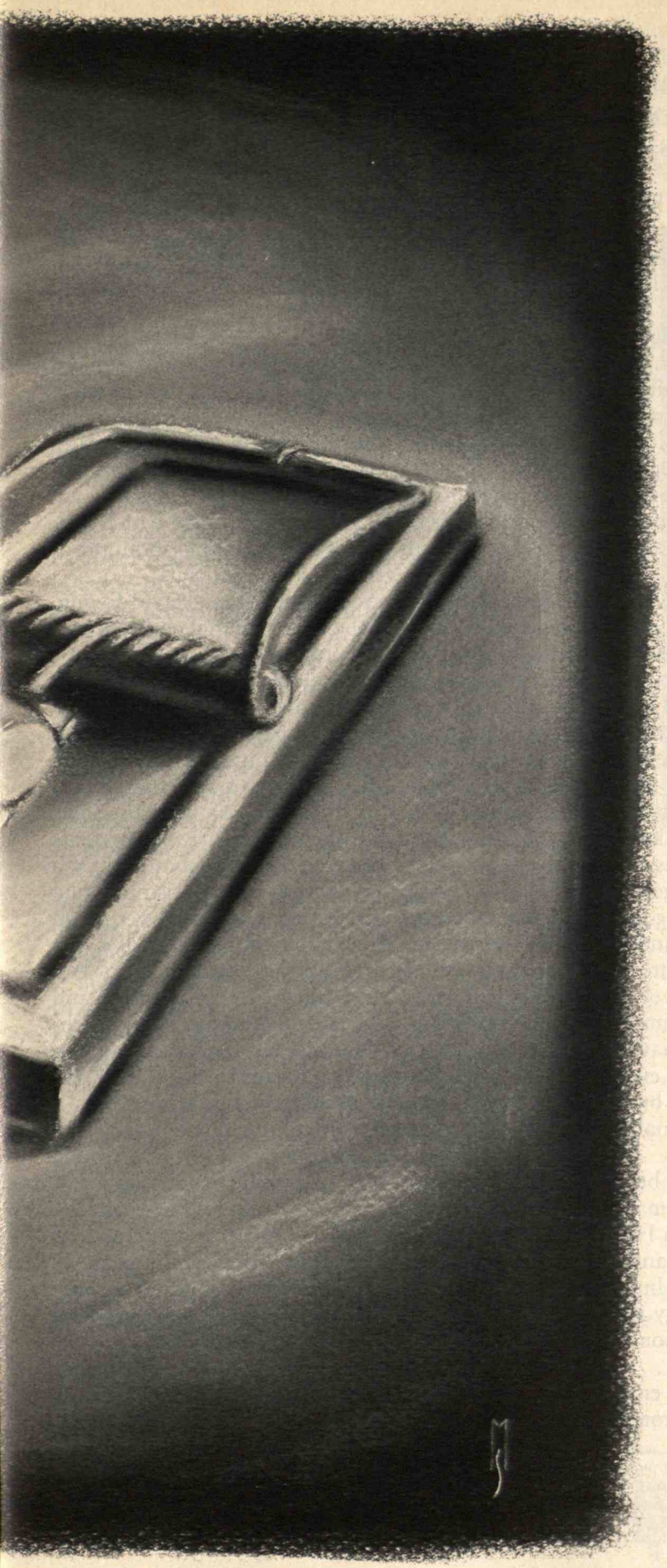


MAKING THE WORLD SAFE FOR WHISTLE-BLOWERS

BY ROSEMARY CHALK

STRONGER MEASURES ARE NEEDED TO ENSURE THAT ENGINEERS AND SCIENTISTS WHO REVEAL DANGERS TO THE PUBLIC DON'T HAVE TO MAKE HEROIC PERSONAL SACRIFICES.

ILLUSTRATION: MARY ANN SMITH



In 1968, air force analyst A. Ernest Fitzgerald made whistle-blowing a household word when he revealed $2 billion cost overruns on the air force C5A transport project and other weapons programs. The Defense Department fired him, but Fitzgerald fought back and in 1982 he was reinstated in his original position. Since that time, he has become an internal ombudsman, taking up causes for others who prefer to leak information privately rather than publicly.

In recent years, many more conscientious scientists and engineers have been willing to go to extreme lengths to reveal dangerous conditions. At the same time, legal protections for whistle-blowers have appeared, as have mechanisms within the government and private industry designed to protect and even encourage such actions.

However, the conditions that provoke whistle-blowing are still prevalent. Numerous press accounts continue to reveal situations in which management has overruled or ignored employees—often people with advanced degrees or technical training—who have reported a threatening situation prior to a major tragedy or incident.

The weaknesses of existing procedures are especially troublesome when the whistle-blower's claims rest upon subjective interpretations of safe practices rather than specific violations of regulatory standards. A concerned scientist or engineer seeking to reverse a punitive personnel action following an unauthorized release faces time-consuming, expensive, and complicated financial and legal problems.

Individual cases illustrate the bleak fate of the whistle-blower and demonstrate the need for tougher legal protections. As director of medical research at Ortho Pharmaceutical Corp. in New Jersey in the late 1970s, Dr. A. Grace Pierce helped develop a product to treat chronic diarrhea in children and elders. The product included large amounts of saccharin, a suspected carcinogen. Pierce objected to this ingredient, but management failed to support her and ordered her to continue work on the drug. When she refused, she was demoted, and it was made clear that she would no longer be considered for senior assignments. She resigned and sued for

FOCUSING ON A FEW VALIANT WHISTLE-BLOWERS LEAVES ALL BUT THE MOST CONSCIENTIOUS SCIENTISTS AND ENGINEERS WITHOUT SUPPORT.

wrongful discharge, saying that her employer had effectively terminated her responsibilities within the company. Referring to the Hippocratic oath, Pierce affirmed that a professional ethic prohibited her from continuing work on the drug.

The New Jersey Supreme Court acknowledged that Pierce had acted according to her conscience, but refused to rule in her favor since she had failed to demonstrate how her action was based on any specific legislation, regulation, court decision, or professional standard. The court said the Hippocratic oath was insufficient to protect her because "a call of conscience should recognize that other employees and their employer might heed a different call."

In many other cases, individuals who speak up about hazardous conditions are singled out for punitive transfers, demotions, or dismissal. Furthermore, legal protections are fragmentary and even counterproductive, at times imposing additional reprisals on the individuals they are meant to protect.

The evidence on the effectiveness of corporate or agency internal mechanisms is less clear, mainly because reporting procedures are new. Yet it is apparent that in almost every case, two factors weaken the effectiveness of public and private procedures to provide more visibility for disputes over dangers. First, individual employees are not always willing to use the procedures. The second factor compounds the significance of the first: top management is often unwilling to reverse decisions made at lower levels.

Professional support for whistle-blowers is similarly well intentioned but insufficient. Societies have honored individual conscientious scientists and engineers, but focusing on a few heroes leaves all but the most determined and courageous professionals without support.

For these reasons, many groups are moving beyond publicizing heroic individuals to foster formal mechanisms to review dissident claims. Stephen H. Unger, president of the Institute for Electrical and Electronics Engineers (IEEE) Society on Social Impacts of Technology, has written, "If technology is to be used in a beneficial manner, the conditions under which engineers operate must be changed. . . . Decision makers cannot be allowed to overrule engineers' professional judgments in a peremptory manner. It should not, for example, require heroic behavior to call attention to a situation in which human lives are jeopardized by faulty engineering."

Internal Mechanisms

In their search for internal methods to document and prevent dangerous situations, the supporters of whistle-blowers have found common interests with managers concerned about the costs of correcting mistakes. Recognizing that experts will disagree on the significance of uncertain hazards, managers are exploring alternative channels through which employees could express dissident opinions about product safety and integrity to senior officials.

Harvard Business School professor David Ewing, who is studying workplace systems that entitle workers to hearings when a conflict arises, says perhaps five companies had such guidelines before 1981. Today, almost 50 companies have adopted them. While direct expenses for these mechanisms are often trivial, the real cost lies in the amount of time and attention senior executives spend to assure that lower-level managers do not stifle constructive criticism.

Monsanto has been one of the early proponents of in-house whistle-blowing, motivated in part by a 1976 Food and Drug Administration decision to ban a plastic beverage bottle that had cost over $100 million to develop. To eliminate future surprises, the company established an early-warning system. According to Ewing, Monsanto relies upon inside and outside experts to serve as devil's advocates in "technology risk reviews." Once a hazard has been identified, management seeks a means to avoid it. If one is not found, product development is stopped.

Monsanto's experience with the herbicide Roundup shows how effective this internal review is. Researchers first formulated the product as a salt that under certain conditions could form nitroso compounds. The risk-review experts discovered that at least one of these compounds had proven carcinogenic in animal tests. The company's research team went back to the laboratory and developed a product that would not form a nitroso compound.

The January 1986 explosion of the *Challenger* shuttle emphasized the federal government's need to expand its own internal mechanisms for avoiding dangerous situations. In its review of the circumstances leading to the explosion, the Rogers Commission expressed shock that higher NASA officials had never heard key technical disputes before the

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launch. Some NASA senior managers indicated that they learned about the initial "no launch" recommendation of engineers at Morton Thiokol, the booster contractor, at the commission hearings (*see sidebar page 54*).

In the aftermath of the shuttle disaster, the space agency adopted the NASA Safety Reporting System (NSRS). The model for the system is the Near Mid-Air Collisions (NMAC) program of the Federal Aviation Administration (FAA) Office of Aviation Safety. In announcing the new procedures, George A. Rodney, NASA's associate administrator for safety, stated that their purpose was to "elevate problems to upper management when standard channels have failed to do so." NSRS is intended to provide a window on festering technical disputes—provided employees are willing to step forward to report them.

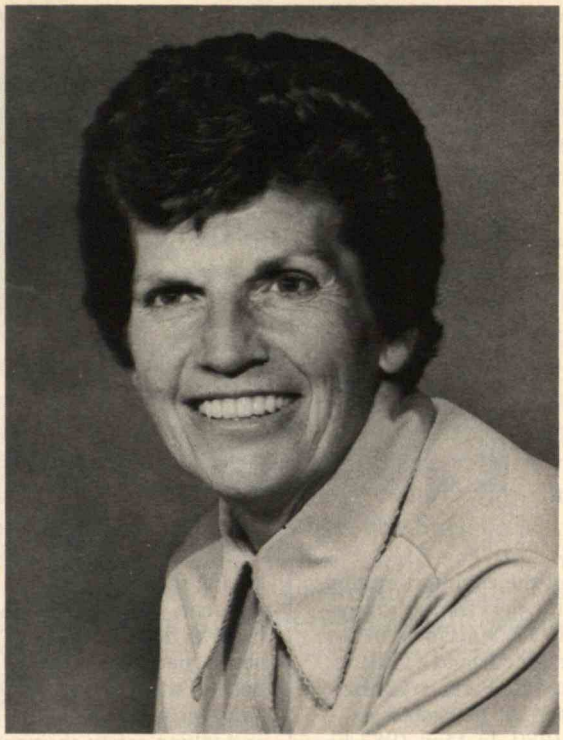
The system relies upon a written form that any employee can complete and mail directly to Battelle Institute in Columbus, Ohio, an independent contractor to NASA. Battelle processes the forms, removes the identity of the informant, and sends a summary to NASA headquarters. The employee is advised to indicate "your recommendation as to whether there should be an immediate review before a launch." The form includes boxes to indicate whether the reported hazards might result in injury or loss of life to a member of the public, flight crew, or operating personnel.

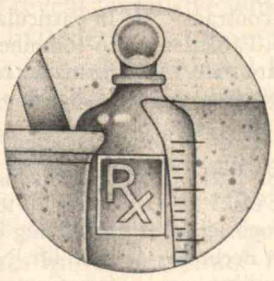
However, a look at the NMAC model suggests that this system is not designed to catch problems like those behind the *Challenger* explosion. One of the government's most popular safety reporting procedures, the NMAC system relies upon voluntary reports from civilian and military pilots and other personnel. Upon viewing or experiencing a "near miss" incident, a crew member files a report with an air-traffic facility. This preliminary report is promptly wired to each responsible FAA office and is entered into an NMAC incident system. An investigator looks into each preliminary report and prepares a final report within 90 days. Crew members filed 758 reports in 1985 and 840 in 1986.

About 19 percent of NMAC incidents involve an apparent violation on the part of an aircraft operator or air-traffic controller. Yet 20 percent of the remaining 81 percent are classified as critical. Over half—56 percent—are potential hazards, and 24 percent are considered to pose no hazard.

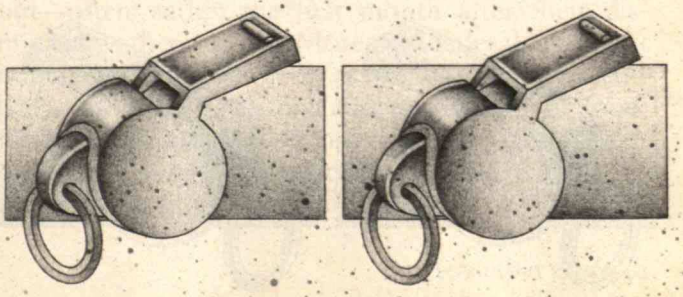
The low proportion of regulatory violations and the comparatively large number of critical or poten-

A. GRACE PIERCE





Dr. A. Grace Pierce left her job with a New Jersey company rather than follow orders to work on a medicine that contains large amounts of a suspected carcinogen.



ILLUSTRATIONS: DAN COLLINS

RICHARD D. PARKS



One of the engineers responsible for the cleanup following the 1979 accident at Three Mile Island (TMI), Richard D. Parks was first assigned to the project in June 1980. In May 1982 he became a senior engineer at Bechtel, the prime contractor for the cleanup. Part of his job was to ensure that equipment complied with federal and plant safety regulations.

In the fall of 1982 Parks joined the head lift task force, a group of engineers and managers from Bechtel and the operating utility, GPU Nuclear. This group would plan the removal of the reactor vessel's 170-ton lid. He became concerned about a crane needed for the task: if it dropped the shields or reactor vessel, contaminated materials might be released. The crane, weighing about 400 tons, had been repaired following the accident.

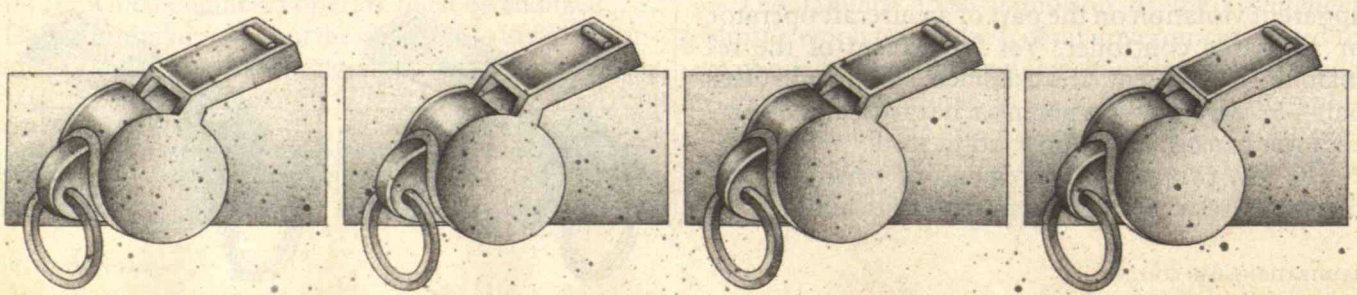
Parks believed that Bechtel was violating procedures and taking safety shortcuts to reduce delays and costs. In particular, Bechtel wanted to combine mandated performance tests with the actual cleanup operation. The company's managers suggested that the crane lift five heat shields, each weighing about 40 tons, as part of the qualifying load tests for the head lift. Nuclear Regulatory Commission (NRC) officials gave the go-ahead to this approach, but Parks and others refused to approve the use of the crane for the 170-ton lift.

The complaints delayed the head lift, but in mid-February 1983, after Parks had disagreed internally with the company's handling of the crane issue, Bechtel suddenly removed him from many of his key duties. Parks went public with his dissent, and a week later Bechtel suspended him, firing him one month later.

Congressional inquiries and a review by the NRC Office of Investigations followed. In September 1983, the NRC report criticized the shortcuts adopted by Bechtel and the failure of GPU to responsibly monitor its contractor's work performance. NRC fined GPU almost $60,000 for harassing Parks. Currently the utility is appealing that decision.

Parks also filed a claim with the Department of Labor (DOL) under the employee-protection clause of the Energy Reorganization Act, alleging that his superiors had harassed him for raising safety concerns. In May 1983 the DOL ordered Bechtel to reinstate Parks in his former position, and to let him resume his responsibilities for the cleanup. Bechtel did so, but soon transferred him. Parks was ultimately laid off, but negotiated a settlement with Bechtel after filing a civil suit against the company.

In May 1986, the IEEE Society on Social Implications of Technology gave Parks an award for outstanding service in the public interest. Part of the citation reads, "Richard Parks followed his best engineering judgment and acted from his sense of engineering responsibility, knowing that he risked his chosen career. His courageous adherence to the highest standards of professional ethics deserves the respect and admiration of the engineering profession."



OVER A DOZEN FEDERAL LAWS, ESPECIALLY MAJOR ENVIRONMENTAL AND OCCUPATIONAL SAFETY BILLS, NOW PROTECT WHISTLE-BLOWERS.

tially hazardous events has led FAA officials to conclude that it may be difficult to obtain firm evidence of violations. Rather than relying solely on a policy of enforcing regulations, the officials suggest other ways to improve safety: additional pilot training for reporting events and further analysis of the methods used to collect and investigate NMAC incidents.

Going Outside the System

These in-house systems are designed to eliminate the need for public whistle-blowing. But in many cases internal review procedures do not exist, are ignored, or are ineffective. As a result, employees may have no recourse but to go outside the firm or agency.

Publicly revealing negligence or ineffective responses to hazards usually carries a high price to the individual who takes such an action. Since most whistle-blowers try to gain attention through in-house channels first, it is unlikely that their identities can be kept secret after they disclose the information to the media or government officials. Such disclosure often brands the whistle-blower as insubordinate—someone who is not part of the team. Because documenting allegations may involve releasing internal corporate reports, the dissenter is exposed to charges of theft or violation of confidentiality agreements. Federal employees might be charged with misusing classified or even, according to recent proposals, "classifiable" information, which could include sensitive details about disputes over contract requirements for weapons-procurement programs.

Fortunately, whistle-blowers who use the courts to gain compensation or reinstatement following a wrongful firing, transfer, or demotion are finding that a variety of statutes are being interpreted to provide extensive protections.

Moreover, at least 26 states have provided direct support for whistle-blowers by recognizing a "public policy exception" to the traditional doctrine that employers can fire workers without cause. According to Stephen M. Kohn, clinical director of the Government Accountability Project (GAP) in Washington, D.C., such measures have "revolutionized the rights of whistle-blowers." GAP is the primary clearinghouse and resource center for whistle-blowers seeking redress through litigation.

Kohn says that the state laws provide means of appeal and compensation for all private-sector employees in the states covered. In most cases, an employee who sues under these standards is entitled to a jury trial and could receive punitive as well as compensatory damages. Of course, the effectiveness of these measures varies. In some states, such as Indiana, the employee cannot be fired for exercising a legal right, but others, such as New Jersey, apply a much broader standard.

Many federal laws also contain useful clauses. Congress has adopted a series of legal protections known collectively as whistle-blower laws. Their basic goal is to provide a means of redress for people who have been punished by their employers for advocating adherence to government regulatory standards. Over a dozen federal laws, especially major environmental and occupational safety bills, now protect whistle-blowers. These include the Occupational Safety and Health Act, the Surface Mining Act, the Safe Drinking Water Act, the Toxic Substances Control Act, the Clean Air Act, the Water Pollution Control Act, and the Energy Reorganization Act.

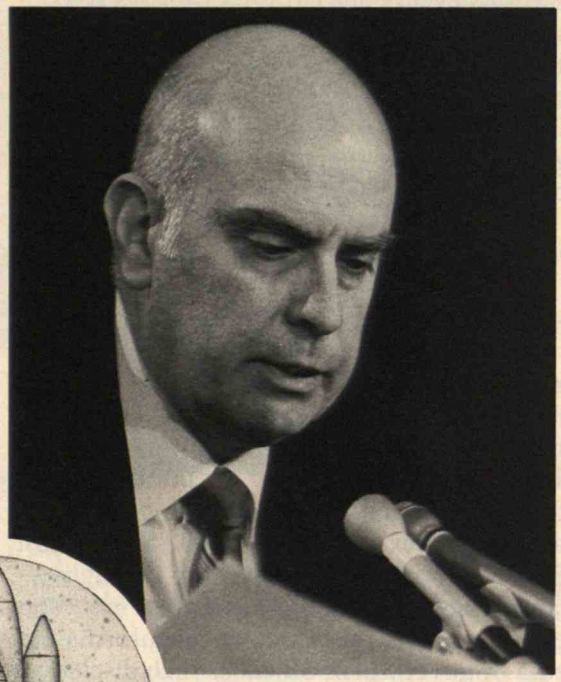
A comprehensive report recently prepared for the Administrative Conference of the United States (a federal agency that advises Congress on administrative procedures) reveals extensive whistle-blowing in areas protected by federal law. Complaints brought under the Occupational Safety and Health Act are by far the largest single category. In fiscal-year 1985, 2,433 complaints were brought under this law; 291 resulted in OSHA filing a civil action on behalf of the complaining employee. The report suggests that a higher level of cases might be pursued if the Labor Department had more personnel and resources. Complaints filed under the Surface Transportation Assistance Act form the second largest group of cases—248 in fiscal-year 1985.

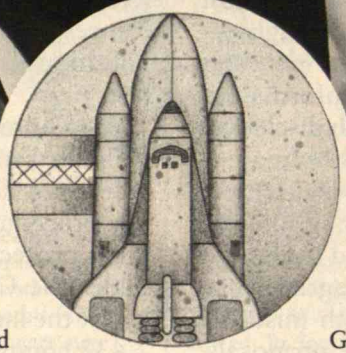
However, the lack of publicity surrounding federal laws limits their ability to encourage whistle-blowing. Employees who are unaware that protective laws exist won't feel safer about revealing problems. And employees who do expose dangers or abuses are unlikely to learn about the existence of legal protections before the statute of limitations runs out—often within the first month after their dismissal or other reprisal. Moreover, federal laws omit important industries such as aviation, pharmaceuticals, and manufacturing and production of food, medical devices, or consumer products generally.

Also, comprehensive reforms are needed to standardize the definitions, procedures, and compensation

MORTON THIOKOL ENGINEERS





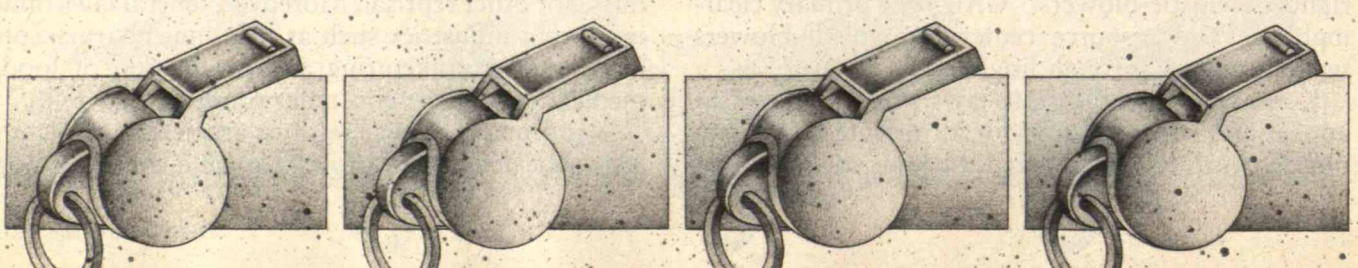


Following the tragic explosion of the *Challenger* shuttle in January 1986, investigators revealed that several Morton Thiokol engineers had questioned the adequacy of the booster rockets' performance at low temperatures. Roger Boisjoly (*right*), seal specialist at Thiokol, and Allen McDonald (*left*), manager of the solid rocket motor program, had argued for many months with upper management about the criteria used to test the joints and gaskets that caused the explosion.

The engineers became even more concerned the day before the shuttle launch, when unusually cold weather was predicted. Fourteen Thiokol engineers "fought like hell all day to get permission for a presentation to NASA," an anonymous senior engineer later told reporters. That evening, mid-level NASA officials and the Thiokol engineers reviewed the effects of low temperature on the gaskets. All 14 engineers and 4 other Thiokol employees recommended postponing the launch.

NASA officials Larry Mulloy and George Hardy challenged the recommendation. Mulloy, the manager of booster programs, questioned the engineers' technical judgment, and Hardy, Marshall's deputy director for science and engineering, said the recommendation "appalled" him. Hardy later explained that he is "likely to probe and sometimes even challenge either a pro position or a con position. The objective of this is just simply to test the data, test the degree of understanding." Thiokol's management reversed the initial recommendation for a postponement.

Roger Boisjoly testified five times before investigating agencies—four times at the Rogers Commission and once at the House Science and Technology Committee. Partway through his testimony, Morton Thiokol reassigned him. Following intense criticism of this move, Boisjoly was reinstated in his position, but his responsibilities were altered. He is now on long-term disability leave and is suing his employer and NASA.



INSTEAD OF STANDING BEHIND WHISTLE-BLOWERS, THE FEDERAL OFFICE OF THE SPECIAL COUNSEL TURNED DOWN 99 PERCENT OF THE CASES THEY INITIATED.

measures designed specifically to protect whistle-blowing. In the words of Tom Devine, GAP's legal director, "legislative policy for whistle-blower protection is still in its infancy." The state laws, though commendable, are complex, and rather than simplifying the situation and providing a uniform framework, federal law is even more complicated.

According to the administrative conference report, the federal laws create a "crazy quilt of investigative, adjudicatory, and review responsibilities." Some laws require elaborate hearing procedures, while others are silent about the means of adjudicating claims. Statutes of limitations range from 30 days to 6 months. Responsibility for investigating claims is scattered throughout the federal government. Where whistle-blowing involves OSHA regulations, that agency investigates and district courts handle adjudication. OSHA also investigates violations of the Surface Transportation Assistance Act, but Department of Labor administrative-law judges handle adjudication. In most cases, employees who lose at the agency level may press their cases through the courts, but individuals who bring claims under the Occupational Safety and Health Act or the Asbestos Hazard Emergency Response Act "are completely dependent upon the willingness of the Labor Department to prosecute their causes on their behalf."

Protections for Federal Employees

The Civil Service Reform Act of 1978 provides the most common means of appeal for federal employees who suffer reprisals after exposing government waste, fraud, or abuse. The act prohibits reprisals against any federal employee who legitimately documents wrongdoing by government officials. It also establishes legal sanctions against officials guilty of reprisals. The employee must file a written complaint with one of two independent agencies, the Merit Systems Protection Board (MSPB) or the Office of Special Counsel.

Two MSPB studies reveal the extent to which employees are aware of fraud, waste, or mismanagement. However, the studies also show that federal workers are reluctant to report abuses and that reprisals are common. In a 1980 study, almost half of the civil-service employees who responded claimed to have observed or have evidence of wrongful activity. Yet of this large category, 70 percent said they did *not* tell any individual or group, primarily because they believed "nothing would be done to correct the activity." Of those who had spoken out, 20 percent reported that they had suffered reprisals.

The second study, in 1983, confirmed these troubling findings. Once again, 70 percent of those who said they knew of wrongdoing did not report it. And about one-quarter of the respondents who indicated that they did report a problem also claimed to have faced some form of reprisal.

The Office of the Special Counsel handles reports of harassment against government employees. However, it rarely reverses management, and its lack of independent action has prompted much criticism. A 1985 General Accounting Office report indicated that the special counsel had turned down 99 percent of whistle-blower cases without attempting any disciplinary or corrective action. In subsequent hearings on the effectiveness of laws protecting whistle-blowers, K. William O'Connor, the special counsel until June 1986, told Rep. Patricia Schroeder (D-Colo.), chair of the House Civil Service Subcommittee, that in his opinion "most whistle-blowers are malcontents." GAP's Devine has suggested that special-counsel protection for whistle-blowers is so poor federal employees would be better off without it.

Congressional criticism has caused a re-thinking of appeals procedures and protective legislation for both federal and other employees. Schroeder, who has championed protection of federal employees who reveal corrupt or dangerous practices, believes managers should welcome, not squelch, this information. She has introduced legislation that would allow federal whistle-blowers whose claims the special counsel has not pursued to directly appeal their cases, although at their own expense, to the Merit Systems Protection Board.

Congress is considering other model legislation to provide comprehensive protection for employees in the private and public sectors. Early in 1987 Rep. Thomas Luken (D-Ohio) introduced a bill that would protect employees who work at nuclear-weapons facilities administered by the Department of Energy. The bill also proposes to expand protections for all federal, state, and local workers who expose environmental problems that violate federal standards. In addition, it would provide a one-year statute of limitations, require notice of the law to be posted in the workplace, and establish punitive damages for reprisals.

An ultimate goal for those concerned with

RECENT STUDIES SUGGEST
THAT THE WHISTLE-BLOWING CASES RECEIVING
MEDIA ATTENTION ARE A SYMPTOM
OF DEEP DISSENT.

strengthening the rights of whistle-blowers is a "National Employee Protection Act"—one that would protect *all* employees. Model legislation, proposed by GAP, would allow people to sue their employers if reprisals occur and would establish a two-year period within which they may initiate such actions.

In the Public Interest

In the absence of uniform legislation, GAP and others concerned with strengthening the legal structure for employee rights must rely upon the complicated tangle of existing complaint procedures. Formed in 1977, GAP provides a range of services. Teams of lawyers and students investigate and evaluate claims of retaliation, and assist in prosecuting the most significant cases. In addition, GAP's Kohn has authored a litigation manual *Protecting Environmental & Nuclear Whistle-blowers* to aid whistle-blowers and their attorneys.

GAP has been involved in over one-third of the almost 300 cases brought under federal environmental whistle-blower laws since 1980, most of which have been filed in recent years. Since 1985, GAP attorneys have won four cases outright, and they have contributed to significant victory through *amicus* presentations in two other cases. GAP is representing Fitzgerald and other air force civilian employees who have refused to sign a new government order prohibiting unauthorized disclosure of classified or "classifiable" information. GAP is also assisting computer engineer Pat Crosby in litigation against Hughes Aircraft in the first defense-industry wrongful-discharge case. The attorneys have settled 19 cases out of court with monetary payments totaling over $700,000; 25 other settlements have resulted in reinstatements or positive job references.

GAP publicizes cases through extensive media contacts. It recently assisted *60 Minutes* in exposing corruption in the U.S. Department of Agriculture's meat-inspection division. More than 70 inspectors had contacted the organization, concerned that relaxed regulations no longer required chickens contaminated with feces to be trimmed—an action needed to kill some bacteria, including salmonella. As a result of the publicity, Congress is reviewing meat-inspection regulation amidst allegations that senior USDA officials are guilty of corrupting the inspection program through political appointments and relaxed contamination standards. Ironically, the public attention has also fostered forced lay-offs and re-assignments of inspectors. Many of these reprisals have been successfully resisted, though.

Professional associations have also increased their activity on behalf of whistle-blowers. They have sent witnesses to job-discrimination hearings and have published reports of whistle-blowing incidents. Various symposia sponsored by scientific and engineering societies, most notably the American Association for the Advancement of Science (AAAS) and IEEE, have highlighted the reprisals and other problems selected individuals have encountered.

In 1982, the AAAS presented its annual scientific freedom and responsibility award to Morris Baslow, a whistle-blower who revealed that his employer, a small consulting firm under contract to Con Edison, had withheld scientific data about adverse environmental effects during government regulatory hearings. Similarly, the Institute for Electrical and Electronics Engineers recognized the efforts of Richard Parks, an engineer who exposed wrongdoing in the Three Mile Island cleanup (*see sidebar, page 52*).

On the whole, however, professional support for scientists or engineers who experience retaliation has been inconsistent. Professional groups lack both experience and access in handling individual cases and have limited resources for investigating and evaluating conflicting or ambiguous claims. More important, association members often remain divided about the appropriate role for professional groups in defending employees who challenge management decisions.

Ending the Need for Heroes

One reason for the ambivalence among professionals may be the widespread and continuing belief that problems are related more to the personalities of individuals than to a basic conflict between professional and managerial practices. To determine how often technical employees encounter situations that violate professional integrity, the Educational Fund for Individual Rights, a nonprofit firm directed by Columbia University professor Alan Westin, conducted a major study in 1983.

Through phone and mail surveys, the study team discovered that 12 percent of respondents "reported that, in the past two years, they have been in situations in which they voiced objection to, or refused to participate in, some work or practice because it

went against their legal/ethical obligations as engineers or their personal senses of right and wrong." Fifteen percent indicated that their employers had "inappropriately" withheld reports from circulation. An additional 8 percent said reports or data had been altered "in such a way that their meaning was obscured or changed significantly."

These figures suggest that the whistle-blowing cases receiving extensive media attention are a symptom of deep dissent in the workplace. Therefore, a powerful role for the professions might be to promote strong internal procedures and legal protections for whistle-blowers. Educational programs designed to enlighten managers, legislators, and court officials about the merits of dissent in technical disputes would help foster model legislation. These programs would also encourage review and publication procedures based on scientific merit rather than hierarchical controls.

The seemingly isolated incidents involving solitary individuals reflect the potential for a much broader pattern of behavior rooted in professional or personal ethics. With comprehensive whistle-blower legislation, increased professional activism, and widespread internal mechanisms, heroism can give way to everyday responsibility.

But for the present, the experiences of whistle-blowers continue to demonstrate the inadequacies of current procedures. Indeed, in 1987 the Pentagon threatened Ernest Fitzgerald with the loss of his security clearance for refusing to sign the new mandatory non-disclosure statement. Individual heroism like Fitzgerald's emphasizes the need for increased attention to the problems of scientists and engineers who take their professional standards seriously. □

FOR FURTHER READING

□ Eugene R. Fidell, "Federal Protection of Private Sector Health and Safety Whistle-blowers," a report prepared for the Committee on Adjudication of the Administrative Conference of the United States, March 1987.

□ Rosemary Chalk and Frank von Hippel, "Due Process for Dissenting Whistle-blowers," *Technology Review,* June/July 1979.

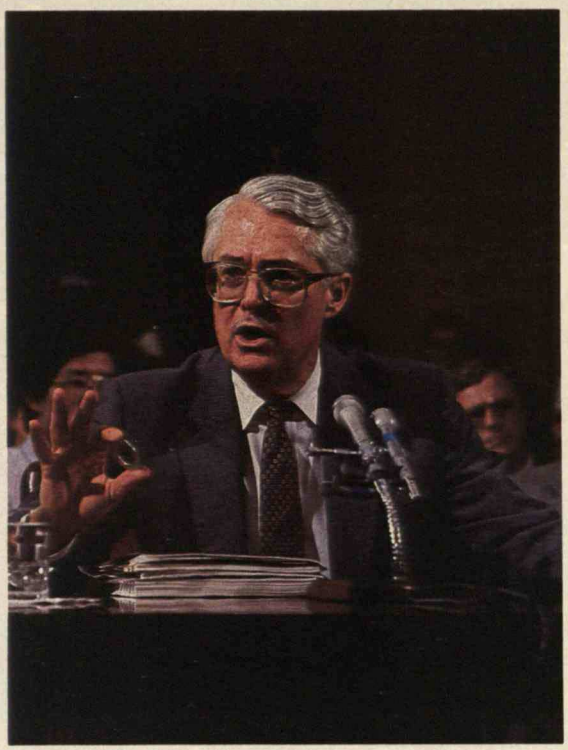
□ David Ewing, *Freedom Inside the Organization,* E.P. Dutton, 1977.

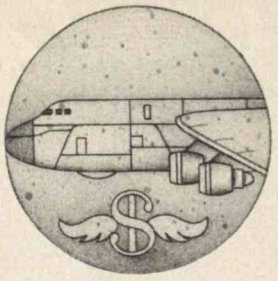
□ Alfred G. Feliu, "The Role of the Law in Protecting Scientific and Technical Dissent," *IEEE Technology and Society Magazine,* June 1985.

□ Stephen Kohn, *Protecting Environmental and Nuclear Whistle-blowers: A Litigation Manual,* Nuclear Information and Resource Service, Government Accountability Project, 1985.

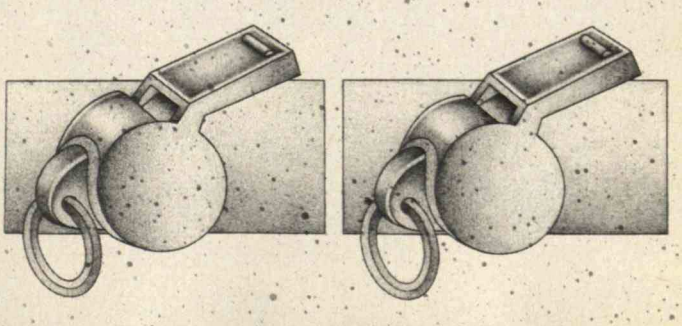
□ Patricia Schroeder, Thomas Devine, Donald Aplin, Stephen Kohn, Thomas Carpenter, and Michael Kohn in the *Antioch Law Journal,* special issue on whistle-blowers and the public interest, summer 1986.

A. ERNEST FITZGERALD





A. Ernest Fitzgerald, the first well-known whistle-blower, got in trouble with his Pentagon employers again in 1987. They wanted to take his security clearance away after he objected to a government order inhibiting disclosures.





This NMR profile captures the subtle topography of the head's soft tissues. Radio-frequency pulses alter the behavior of hydrogen nuclei, which are abundant in soft tissues with their large concentrations of water. The different times the nuclei take to "relax" afterward indicate density variations.

NMR:

The Best Thing Since X-Rays?

BY JUDITH E. RANDAL

THE speech of a man in his early twenties is barely intelligible, his handwriting a hard-to-read scrawl. His coordination is terrible and there are times when, despite anticonvulsant drugs, he has hundreds of seizures a day. His disabilities began just before his second birthday, yet for over two decades no x-ray or other test has been able to explain their cause.

An examination of a new technology that produces startlingly clear images of the human body.

Then he is placed in the hollow cylinder of a giant magnet that, coupled with other equipment, produces startlingly clear images of his brain. The images yield a clue—a bit of tissue that is apparently normal but misplaced. Exploratory surgery confirms that the tissue is indeed the source of the young man's problems, and it is removed. Five months after the operation, he is free of seizures and his coordination, speech, and handwriting continue to improve.

This is a best-case scenario for nuclear magnetic resonance (NMR) imaging. Many physicians use superlatives like "astonishing" and "spectacular" to describe the clarity of the images produced by this technology. Enthusiasts say NMR is the greatest diagnostic advance since Wilhelm Roentgen discovered the penetrating powers of x-rays in 1895.

Dr. Lee Rogers, chairman of diagnostic radiology at Chicago's Northwestern University Medical School, contends that "for most applications, NMR is superior beyond question" to

PHOTOS: HOWARD SOCHUREK

other diagnostic imaging techniques. While x-rays give only anatomical information about tissues, NMR tells something about their chemical makeup as well. And NMR can detect lesions that would be hidden by overlying bone in x-rays. This explains why NMR enabled physicians to learn what ailed the young man.

NMR is also heralded as a way to spare many patients exploratory surgery or the risks of x-ray studies. Unlike x-rays, NMR does not use ionizing radiation, but forms an image by tuning in to the magnetic fields naturally generated by the nuclei of certain atoms in the body.

NMR units are proliferating almost as rapidly as did x-ray computed tomography (CT or CAT scan) machines a decade ago. As of late 1986, there were about 650 NMR machines in this country. By 1987, 10 manufacturers had obtained Food and Drug Administration approval to market these devices despite their staggering price tags, which run from $1.5 million to $2 million or more.

Today NMR is proliferating almost as rapidly as CAT scans did a decade ago.

Yet some experts doubt how widely useful NMR will be. One of these is Dr. William Stason of the Harvard School of Public Health, who has served as a consultant on NMR for both the Blue Cross-Blue Shield Association and the American Hospital Association. Stason is convinced that NMR is better than CT for producing images of the back of the brain, the brain stem, and the upper spine. But he feels that it may not provide more information than CT in many other areas of the body, and he believes that the extra information it does yield may often make little difference in how physicians treat their patients.

"CT was a breakthrough technology," he explains, "because it offered a whole new dimension of diagnostic capability. But NMR is, if anything, a slight improvement on CT in some instances and a significant improvement in a few others. It's a breakthrough technology only in the sense that it is based on a whole different set of [physical] principles."

Even the name of this diagnostic technique is controversial. Radiologists tend to call it "magnetic resonance." Their publicly stated reason is that dropping the "nuclear" from the phrase frees it of distasteful associations with Hiroshima and Three Mile Island. But turf is also an issue. Radiology and a somewhat overlapping specialty, nuclear medicine, are competitors in the diagnostic arena. Thus, physicians with nuclear-medicine credentials usually prefer the term NMR.

How It Works

As mentioned, NMR imaging is based on magnetic principles. The hollow magnet in which patients are placed for scanning causes the nuclei of hydrogen atoms (the "N" in NMR) to line up parallel to the magnetic field and resonate (the "R"). A radio-frequency pulse is sent into the patient's body, causing the resonating nuclei to change alignment. In their new alignment, the nuclei themselves begin generating a voltage in a copper coil surrounding the patient. This voltage is recorded by a computer. When the radio-frequency pulse subsides, the nuclei revert to their previous alignment and stop generating a voltage. As the process is repeated, the computer converts the information it has received into two-dimensional images.

The principles underlying NMR imaging are entirely different from those of x-ray methods, and not just because x-rays expose the patient to ionizing radiation whereas NMR does not. X-rays show up as shadows—dark, light, or somewhere in between—reflecting how much ionizing radiation the target tissue has absorbed. The amount varies according to the density of the tissue. NMR is instead tuned to hydrogen, a major constituent of water, which the body, of course, contains in abundance. NMR thus provides information not only about the density of tissue, but, to a limited extent, about its chemical composition as well.

NMR spectroscopy, a sister technology to NMR imaging, may well provide more detailed biochemical profiles of living tissue. NMR spectroscopy is still only a research tool and requires more powerful magnets than NMR imaging. However, it is maturing fast and is expected to be ready for general medical use within five to ten years.

NMR enthusiasts foresee a bright future for this kind of spectroscopy. At the University of Pennsyl-

JUDITH E. RANDAL reports on science and medicine for Newsday *and contributes to many magazines.*

vania, for example, Dr. John Leigh, an NMR researcher, believes it may help to make cancer chemotherapy more effective. He explains that antitumor drugs are currently given at dosages and intervals based on the average patient's biochemistry. Since these drugs are highly toxic, patients can die from treatments before they succumb to the disease itself. Or they can be undertreated—a mistake that can be fatal, too. NMR spectroscopy, Leigh believes, should allow doctors to steer clear of these pitfalls by adjusting therapy to the individual. And he predicts that this will be possible not only with cancer, but with other chronic diseases, too.

Using neither ionizing radiation nor injected dyes, NMR is absolutely non-invasive.

Safest of Imaging Technologies

For the moment NMR imaging dominates the field. Not only is it thought to be exceptionally safe because it does not expose the patient to ionizing radiation, but it also has another advantage. NMR scans can be done without injecting dyes, or "contrast materials," into the patient's bloodstream, which is necessary in many kinds of x-ray studies to make tissues show up on film. About one patient in 40,000 has a reaction to contrast materials. Most reactions are minor, though unpleasant—nausea, vomiting, and headache, for instance—but others are more serious and even potentially lethal. About 250 deaths from contrast materials occur in the United States each year.

To be sure, contrast materials for NMR have been developed that, as one radiologist put it, "make its already superb images even better." Food and Drug Administration approval of the first one—gadolinium DPTA—is expected early this year. Still, NMR contrast materials are so chemically different from those used with x-rays and are given in such small doses that no problems are expected from their use.

Nonetheless, there are some patients for whom NMR could be hazardous. These include people wearing heart pacemakers—there is concern that the radio-frequency pulses could disrupt their function—and those who have shrapnel or surgical clips containing ferrous metal in their bodies. Those on life-support systems with steel parts are at risk as well. Experts recommend NMR exams for pregnant women only as a last resort because of possible injury to the fetus. And since the scans generate heat, special care is needed with patients who have fevers or are elderly and so have low tolerance for heat.

Some patients are too obese to fit into the magnet, while others are unable to lie still for the 45 minutes to an hour or more needed for a scan. So cramped are the confines of the magnet and so noisy are many models that even a few minutes inside them can seem like an eternity and give rise to claustrophobia. Sedatives can counter restlessness and anxiety, but they aren't without risks, especially for some critically ill patients.

How Good Is It Really?

It will not be easy to resolve differences of opinion about the significance of NMR. In 1983 the National Cancer Institute launched a limited trial, still incomplete, comparing NMR imaging with other techniques. Some of the technology's proponents have objected even to this modest evaluation. For example, Northwestern's Rogers has noted that testing NMR against other procedures means sealing it "in a time capsule" when, in fact, it is fast improving. The NMR scanning methods challenged by any trial, he asserts, would be out of date before the study could be completed.

The "moving target" and other arguments against trials have failed to sway other experts, including Dr. Earl P. Steinberg, assistant professor of medicine, health policy, and management at Johns Hopkins University. Senior author of a 1984 report on NMR for the congressional Office of Technology Assessment, Steinberg maintains that "the more [imaging] technologies that become available, the more important it is that the comparative efficacy of each be adequately evaluated and defined."

Last October an expert panel assembled by the National Institutes of Health heard from 20 speakers about the capabilities of NMR. The chairman, Dr. Herbert L. Abrams, who is professor emeritus of radiology at Harvard and on the radiology faculties at Stanford and the University of California, San Francisco, summed up the panel's conclusion that this "innovative technique . . . is an extraordinary addition to our diagnostic armamentarium." Nevertheless, the panel pronounced only some applications well enough tested for routine use.

Perhaps the best known use is detecting tumors in the posterior fossa, a region at the back of the brain below the ears. Largely because NMR can ferret out growths there that otherwise would be obscured by bone, the panel unanimously agreed that, for such tumors, it is "the diagnostic method of choice."

On the other hand, the panel added that CT and NMR are equally adept at identifying some brain tumors, and that CT is superior for still others. NMR was called "useful" for diagnosing head injuries, although those less than four days old, said the panel's report, "are more reliably demonstrated by CT."

The costs of NMR may outweigh its benefits, and questions remain about how it will affect care.

The report hailed NMR "as the most sensitive imaging technique for the diagnosis of multiple sclerosis" (MS), but with qualifications. The brains of patients with MS generate characteristic bright spots on NMR scans. The trouble is that bright spots in the brain may also indicate AIDS and other diseases, and when the patient is 55 or older, they may just be a normal consequence of aging. Thus, the patient's medical history must be taken into account in diagnosing MS.

Some uses for which the panel endorsed NMR examinations—diagnosing knee problems, for example—may save money. Ordinarily, physicians examining the knee use arthrography or arthroscopy, invasive and uncomfortable procedures that usually require hospitalization. NMR is not only painless, but can be done on an outpatient basis and so is more economical.

The biggest problem with NMR may be overuse, according to two University of Washington internists, Eric Larson and Daniel Kent. They were asked by the American College of Physicians to evaluate the application of NMR to the brain and spine and concluded that over 90 percent of the research reports they reviewed "probably inflate NMR's ability to detect disease." Kent said this is not surprising. New applications of NMR are often first studied in very sick patients whose diagnosis is already known. Also, NMR innovators quite naturally are not entirely dispassionate.

Although it is hard to be sure, Kent believes that in the long run NMR will replace many diagnostic techniques now employed in radiology. But as an example of the mischief that over-zealous use of NMR can cause in the meantime, he cited the case of a woman in her eighties who had had a mastectomy for breast cancer 20 years earlier. When NMR detected bright spots in her brain, the radiologist thought the cancer had spread to her central nervous system and told her she would need a brain biopsy, which would have required opening her skull. Fortunately, the wisdom of an experienced neurologist prevailed. He found no signs of a recurrence of cancer and sent her home reassured.

Too Little for Too Much?

No diagnostic technology is perfect, so allowances should be made if NMR makes some mistakes. Still, it is staggeringly expensive. The machines, which cost a whopping $1.5 million apiece, typically last only five or six years. And while stronger magnets would enhance imaging now and spectroscopy in the future, these in turn call for larger systems that cost $2 million or more.

The costs don't stop with the machine. NMR facilities require special shielding lest other magnetic fields interfere with the machines' performance. Also, without such shielding, the machines could wipe out the data on nearby computer tapes. A 1985 American Hospital Association study of seven NMR installations reported price tags ranging from $340,000 for renovating the basement of an existing building to $4 million for constructing brand new facilities. Granted, mobile units come already shielded, and hospitals or doctors' groups can share them, thus lowering overhead. But even a mobile unit costs $750 thousand to $1 million.

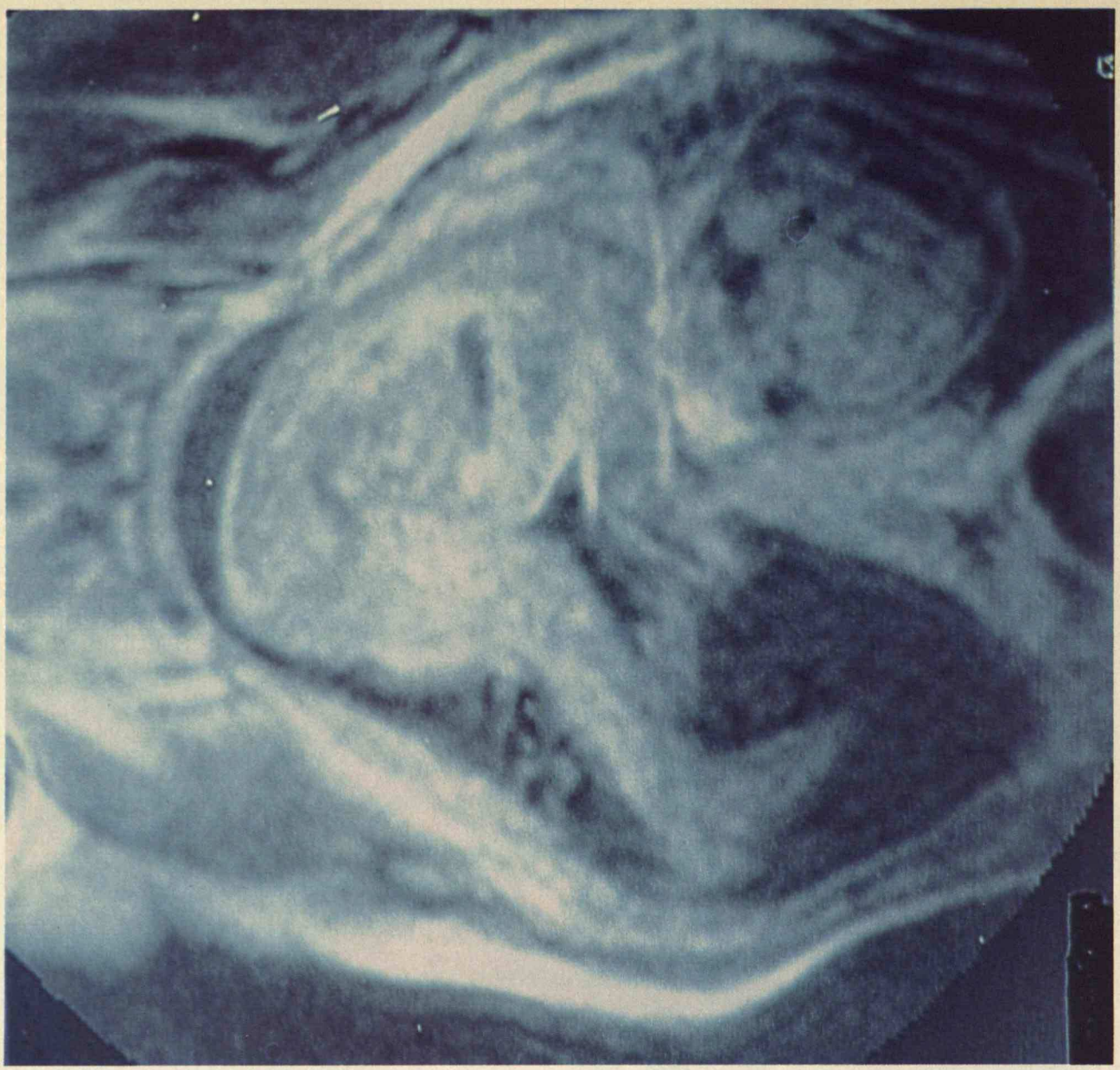
Once it's installed, NMR costs more to operate than does any other commonly used diagnostic imaging technology. Electric bills for a single unit may run as high as $18,000 a month. And since NMR takes longer than CT and other scanning methods, it accommodates fewer patients in a working day. Thus, CT scans typically cost $150 to $200 each, while NMR scans are $500 to $1,000 apiece.

Finally, radiologists and subspecialists need considerable training to learn how to perform NMR scans, and they often require the help of a health physicist or electrical engineer. While some experts claim that experienced radiologists or specialists in



This NMR image is of a man recovering from a motorcycle crash. He has lost control of his lower extremities, but his condition is operable since his spinal cord has not been severed. Rather, a fragmented edge of a lower vertebra is pressing on it. Without NMR's unique capacity to "see" around vertebrae to the spinal cord, his physicians might never have known this.

The advantage of CAT scans over NMR, particularly in examining bone, is their three-dimensionality. "High relief" images like this one (inset) of a damaged vertebra are based on dozens of scans meshed by computer.



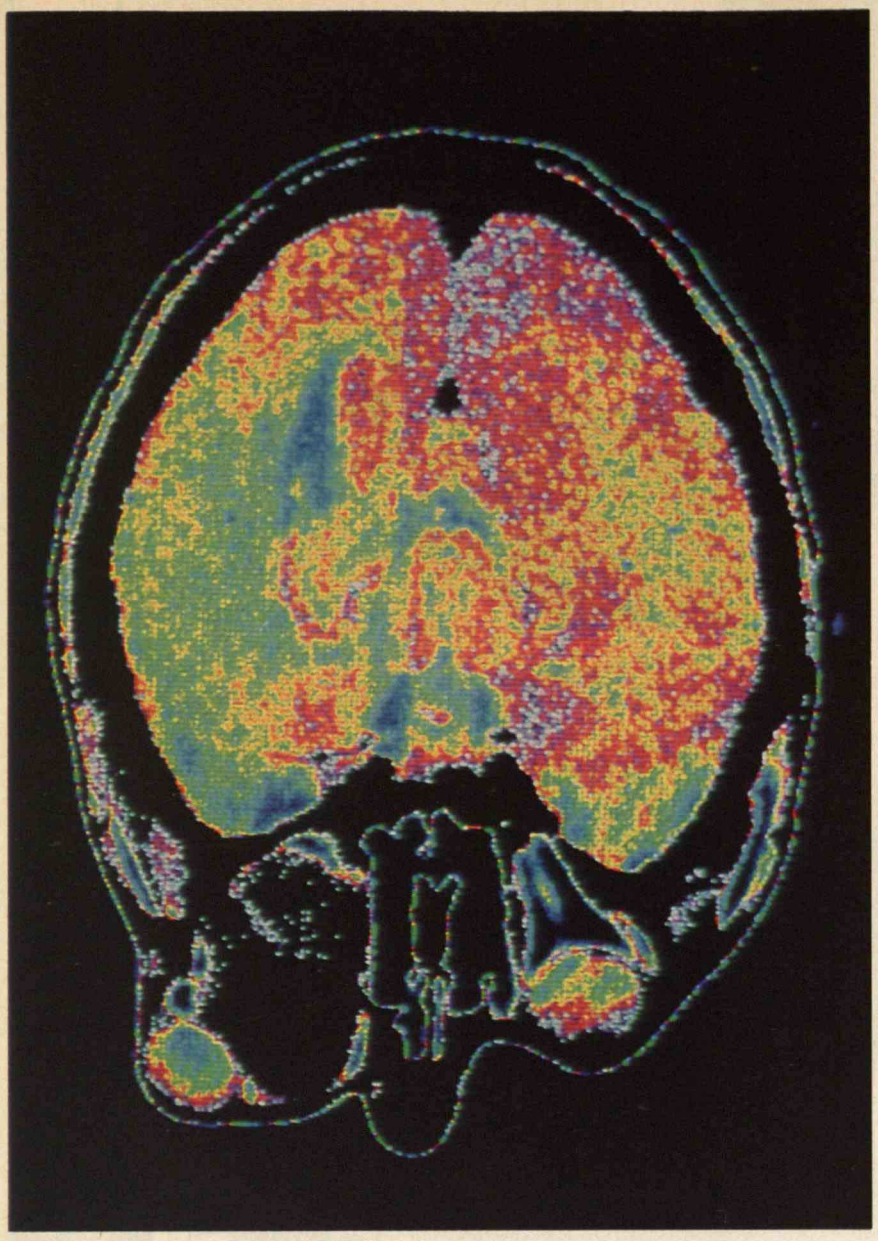
nuclear medicine can become reasonably proficient in NMR in three or four months, others say a year and a half is more like it. Such lengthy training is needed in part because the equipment can be programmed in far more ways than CT can. Also, apparent similarities between NMR-generated images and those produced by older methods may be deceptive, so time is needed to learn to interpret them.

Getting the hang of NMR scanning almost invariably means using both it and other imaging methods on the same patients. Such duplication also drives up costs. Some manufacturers add to these costs by slipping extra features into their basic NMR packages. For example, one company includes a teleconferencing system that customers can use to discuss scans with the firm's technical experts. Although both the machines and such services have often been provided to research centers without charge, this promotional technique cannot be expected to continue.

Here to Stay

Despite its costs and the debates about its usefulness. NMR seems destined to become entrenched on the medical scene. Insurance coverage for NMR is already a reality. Medicare payment for the scans began in November 1985, and most other health-insurance plans—albeit with some restrictions—have followed suit.

The Prospective Payment Assessment Commission, set up by Congress to advise it on Medicare reimbursement policy, estimates that replacing about 30 percent of other diagnostic services with NMR would be beneficial to patients and cost-effec-





Far left: This NMR "photo" of a third-trimester pregnancy reveals that a breech birth will be inevitable. British doctors routinely use NMR during pregnancy, since they feel it endangers neither mother nor child.

Left: An NMR view shows the right eye pressed strangely out of its socket by a tumor growing along the optic nerve. The nerve, which shows up as a little string running backward from the eye, was so close to the tumor that a miscalculation in surgery might have resulted in loss of sight. Physicians decided to use radiation for treatment instead.

Above: When this cancer patient complained of pain in the neck and chest, his doctor ordered an NMR scan to determine whether the disease had metastasized to that area. It hadn't: the vertebrae are well defined with normal spacing.

tive. The commission feels Medicare should encourage hospitals to move in that direction by increasing NMR reimbursements for two to three years.

Richard diMonda, a health-policy analyst who compiled a report on NMR for the American Hospital Association, believes competition among hospitals may pressure them to acquire the technology even without such financial lures. Hospitals also compete with the independent diagnostic-imaging facilities that are installing NMR. And Americans don't hesitate to sue when they are disappointed with the results of their health care and feel that it has fallen short of the state of the art. Malpractice suits alleging negligence for failure to use NMR aren't yet commonplace, but as lawyers and physicians become familiar with it, that could change.

Unfortunately, as they proliferate, NMR units are likely to join other costly technologies in underscoring the gap between those who have health insurance and the estimated 37 million Americans who do not. Public hospitals often can't afford the substantial capital outlays for new equipment, and they are precisely the hospitals that care for the poor and the medically indigent. Moreover, in some states all hospitals must get the approval of health-planning authorities before making substantial investments in new technologies. Freestanding diagnostic facilities have not yet been subjected to this kind of regulation, and these facilities generally exclude patients who do not have insurance.

NMR may well end up being overprescribed for those who can afford it and underprescribed—or unavailable—for others who really need it but lack the wherewithal. □


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THE REAL CHALLENGE OF Japan's Fifth Generation Project

BY ROBERT CHAPMAN WOOD

WESTERNERS greeted the announcement of Japan's Fifth Generation project—the ambitious 10-year government-industry effort to create a new kind of AI computer—with a cry of alarm. Yet today, as the undertaking reaches its halfway point, it is provoking growing skepticism in the United States. Articles in the American press claim that the project is falling short of its original goals and has been sharply curtailed. One article even claimed that the program was "having trouble maintaining the active interest of its participants."

The Fifth Generation project aims to develop a prototype of the computer system on which artificial-intelligence programs of the 1990s will run. This system will be based on the technology of parallel processing (the manipulation of data by many different processors at the same time) and require new computer languages. The resulting machine is supposed to be capable of making 1 billion logical inferences per second—working 2,000 times faster than today's standard for AI work.

Both Japanese and Western scientists believe that parallel processors will be used a decade or two hence for a wide variety of purposes. They expect that such computers will

Even if this national effort to build an AI computer fails to reach its technical goals, it will give Japanese industry a big advantage.

ILLUSTRATIONS: GARISON WEILAND

communicate in ordinary Japanese or English and be able to understand and analyze written information in any field of human expertise, providing "advice" comparable to that of human experts. Such machines could teach basic skills, make medical diagnoses, and translate languages far better than can computers of today.

Early press coverage of the Fifth Generation project often suggested that the Japanese were trying for breakthroughs in every facet of AI technology—an impression that leaders of the project did little to discourage. Thus, today outside observers see good reason for disappointment. The program has yielded few breakthroughs and some work has been abandoned. For example, Japanese scientists acknowledge that special hardware designed to continually sort information in the computer's memory—keeping the most-used data readily available as the human brain does—hasn't worked well.

However, plans originally published for the project show that its directors did not expect a stream of dramatic technologies to emerge by now. Researchers were supposed to focus on "basic technological development" during the project's first three years. This entailed creating new AI languages and designing a special processor that would run those languages quickly. Only in the fourth year were scientists scheduled to begin specific efforts to construct the Fifth Generation computer's main subsystems, including the one that will be able to make logical inferences using many processors at once. This work has begun but is nowhere near completion. The target date for the prototypes remains the spring of 1989.

Yet no matter what the program's outcome, the challenge it poses does not lie principally in the virtuosity of the technical achievements it seeks. Rather, the project is significant because it encourages government and industry scientists to focus on the hundreds of often mundane problems that need to be solved before sophisticated AI computing can be truly useful and profitable. The Fifth Generation program and related Japanese projects remain the only fully developed vision of how the key technology of parallel processing can be commercialized.

Even if the project's prototype computer turns out to be unsuitable for massive commercialization, chances are that this joint government-business-university effort will provide benefits that AI work in the United States will not. The bottlenecks that remain to be solved, in fields such as semiconductor manufacturing and computer software, are likely to have vital commercial applications. By providing an environment where researchers from most of the key industrial laboratories can work on these problems, the Fifth Generation project makes it likely that businesses will understand the cutting-edge technologies well enough to put them to use quickly.

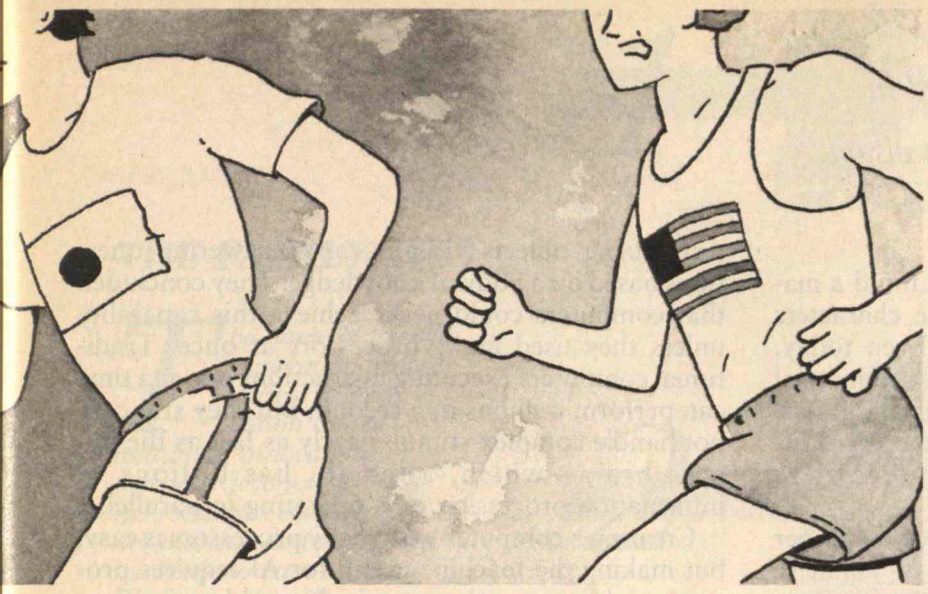
Japan's government has long sought to harness new technologies for the nation's economic benefit. In the 1970s, government-industry collaborations helped commercialize techniques for desalinizing water, refining heavy crude oil, and producing very large scale integration (VLSI)—computer chips that contain hundreds of thousands of transistors. At that time these technologies were mature enough to allow scientists to foresee applications that would meet important business needs. But they were still so far from practical use that private firms were unwilling to commit many people and funds to developing them. By putting both government and key private labs to work on the problems, the Japanese ensured that their companies would become leaders in these fields.

Like dozens of other Japanese government-industry projects before it, the Fifth Generation project is designed to help both managers and engineers understand and eventually profit from a technology that is still years from fruition. Thus, in addition to posing an important technological challenge in its own right, the program offers the U.S. a valuable lesson in the tactics of technological competition.

Bridging the Generations

Early in their modernization, the Japanese realized that if they waited for major foreign companies to sell them technology, they might never learn how to build efficient ships and factories. Slight edges in technology could create highly successful businesses. If, on the other hand, the Japanese sent study teams abroad to learn the vast array of techniques involved in silk reeling, steel making, and later automaking—and if they sought out free-lance experts with no reason to keep secrets from them—they could rapidly catch up with the West. This became Japan's

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Government support of advanced research falls short if it does not include a vision of how discoveries can be made productive.

first technology strategy, one that led to their organized research efforts of today.

Foreign observers have often overestimated the success of Japan's attempts at economic planning. In fact, the Japanese government has made ignominious errors when intervening in the economy. In the 1950s, the Ministry of International Trade and Industry (MITI) delayed granting Sony and other companies the foreign exchange they needed to import key technologies such as the transistor. It channeled financial support to big heavy-industry firms at the expense of smaller, more productive companies. In the 1960s, MITI officials tried to consolidate the entire Japanese auto industry under the control of a few large firms, because MITI thought firms like Honda, Mitsubishi, Toyo Kogyo (the maker of Mazdas) and Fuji Heavy Industries (the maker of Subarus) could never compete in the international marketplace. Even in Japan, the government cannot "pick winners" better than private entrepreneurs.

But governments often must supplement the activities of the private sector—in choosing where to locate a road or port facility, for example. Today the long-range development of new technology requires this kind of intervention. And such government support of advanced research falls short if it does not include a vision of ways that discoveries could be made productive. For example, semiconductor researchers may find a new material that offers great promise. But if the complex problems posed by the manufacturing process are not solved, that research is wasted. Private companies can't usually devote resources to very long range projects. And when a technology is far from commercialization, the company that discovers it or solves some key problems may find that a competitor copies the work and captures the benefits.

The Japanese government has sought since the 1970s to work with private firms to encourage the development of genuinely new technologies. Two such projects are often described as prototypes of the Fifth Generation project: the Fourth Generation project and the Pattern Information Processing Systems (PIPS) project.

The Fourth Generation project was aimed at creating the technology to manufacture VLSI. When the project was launched, the most powerful chips in use had only tens of thousands of transistors. U.S. firms controlled the world semiconductor market. Today Japanese firms have captured 70 percent or more of key sectors of the U.S. semiconductor market, including that for random-access memory chips.

It is difficult to gauge the effect of the Fourth Generation project on Japanese VLSI production. Although the project channeled government research funds to leading companies such as Fujitsu, Hitachi, and Nippon Electric, the technologies used to manufacture VLSI circuits were ultimately developed privately, without direct government intervention.

Yet even though the project created little directly useful technology, Japanese officials argue that it was a good investment. Ikuo Makino, a former official of MITI's General Affairs Department, comments: "If there had been no project, no one would have discussed the VLSI in Japan at that time. When research will take many years, CEOs will allocate only a small amount of money for it. But because we had a VLSI project, everyone in Japan started working on VLSIs at an early stage."

An even more important antecedent of the Fifth Generation program was the PIPS project, conducted from 1971 to 1980. With a budget of some $125 million, it was the largest MITI-sponsored research project of the decade. PIPS involved scientists and engineers from the same leading companies that participated in the Fourth Generation project and later

Although Japan's PIPS project failed to reach its goals, it succeeded in creating the technology of machine vision.

the Fifth Generation project.

The PIPS project's stated goal was to build a machine that could recognize the Chinese characters used to write the Japanese language. Even today, that goal has not been achieved on a commercial basis. There are thousands of Chinese characters, and different people write them in dramatically different ways. Creating a machine that can recognize them is a Herculean task.

Nevertheless, the PIPS project produced a number of technological innovations of value to Japanese industry. Business managers are reluctant to disclose exactly which of their devices depend on PIPS research. However, Laurin Herr, a New York–based consultant specializing in the Japanese computer graphics industry, credits PIPS with developing a powerful microprocessor originally called the PULCE—PIPS Universal Computing Element—and later sold commercially as the Toshiba T88000. According to Herr, the PIPS project also produced the technology of machine vision used in robots, thermal heads for printers, and bar-code scanners. Some products, including the Toshiba T88000 and an image processor—computer hardware that analyzes the output of a camera or similar device—were marketed by private companies with only slight modification. Partially as a result of PIPS successes, the Japanese today dominate key aspects of pattern-recognition technology. U.S. companies, enjoying a strong market in the Defense Department, remain competitive in many types of hardware and software that process the images.

Thus, despite its failure to produce a machine that could read Japanese, the PIPS project is widely considered a success. Though its stated goal was audacious, its achievements—however incomplete—were extremely useful.

Forward to the Fifth Generation

MITI launched the Fifth Generation project in 1982, just one year after the end of the PIPS project. As the 1980s began, MITI-affiliated scientists realized that artificial intelligence and parallel processing would be key technologies in the 1990s and beyond. They also concluded that the two had to develop together.

Japanese scientists define artificial intelligence as the ability of machines to produce "human-like responses," including understanding natural language, recognizing objects visually, and answering questions based on a body of knowledge. They concluded that computers could never achieve this capability unless they used many processors at once. Traditional computers executing instructions one at a time can perform millions in a second. But they still cannot handle complex stimuli nearly as fast as the human brain—which, after all, has billions of information-processing cells operating in parallel.

Creating a computer with many processors is easy, but making the machine useful for AI requires processors able to work on a single problem in close coordination. Creating the hardware and software to allow the processors to work simultaneously on a wide range of problems is an even more awesome task.

The Fifth Generation project aims specifically to produce AI computers that will use logical rules rather than arithmetic operations to act on information. For example, a computer programmed with an AI-oriented language can easily understand that if Dumbo is an elephant and elephants are gray, then Dumbo is gray. This would be relatively difficult to program in a traditional computer, and it is known as "knowledge processing."

By choosing a single approach to this problem and concentrating a significant share of Japan's AI work on that approach, the government hopes to advance the position of Japanese companies in this crucial field. For an effort focused on a single idea whose economic potential is far from realization, the Fifth Generation project's $36 million annual budget is large. Compared with the budgets of other government programs in Japan and elsewhere, however, it is a modest sum—substantially less than, say, the $104 million allocated for the U.S. Strategic Computing Initiative pursued by the Defense Advanced Research Projects Agency (DARPA).

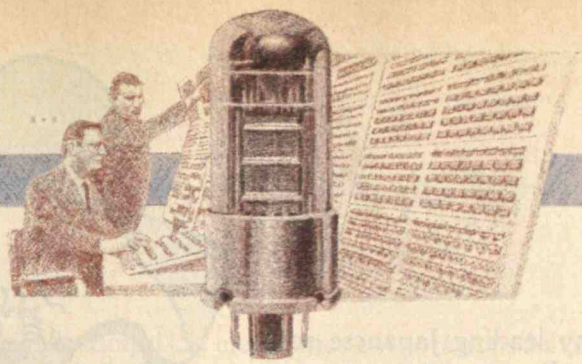
The Fifth Generation project is administered by the Institute for New Generation Computer Technology (known as ICoT), established for that purpose by the Japanese government. Headed by Kazuhiro Fuchi, who authored the plan for the PIPS project, ICoT includes 11 sponsoring organizations: MITI's Electrotechnical Laboratory, Nippon Telephone and Telegraph, Kokusai Denshin Denwa, and the electronics companies Fujitsu, Hitachi, Nippon Electric, Mitsubishi Electric, Matsushita, Oki, Sharp, and Toshiba.

The project is structured to allow the participation

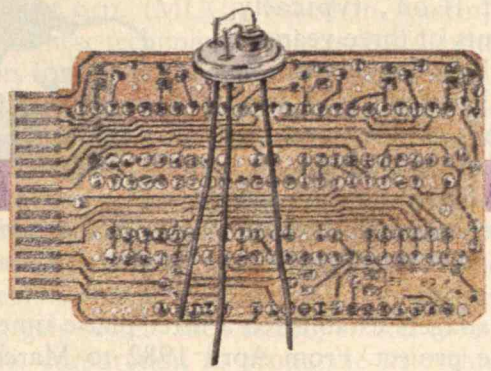
THE FAMILY TIES

The name of the Fifth Generation project derives from its location on the continuum of innovations in computer technology. Japanese scientists consider the original vacuum-tube-based machines to have been the first generation. The second generation used transistors. The third was based on integrated circuits—chips that combine many transistors and other electronic components. In the fourth generation, large-scale and very large scale integrated circuits combined hundreds of thousands of components on a single chip. After completing the fifth generation's parallel-processing computer designed to run artificial-intelligence programs, Japanese scientists hope to create a sixth-generation computer composed of biological elements. This effort—pursuing a technology comparable to the human brain—has been named the Human Frontiers program and was announced earlier this year.

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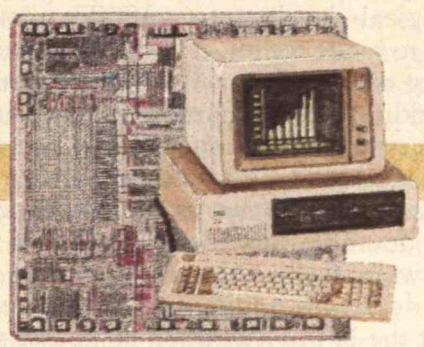
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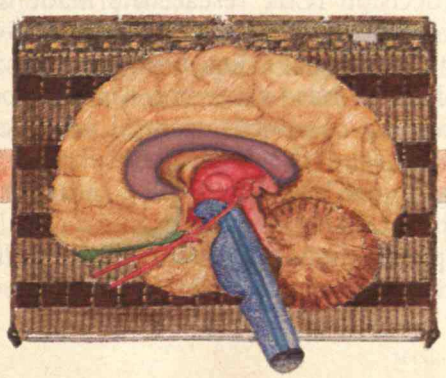
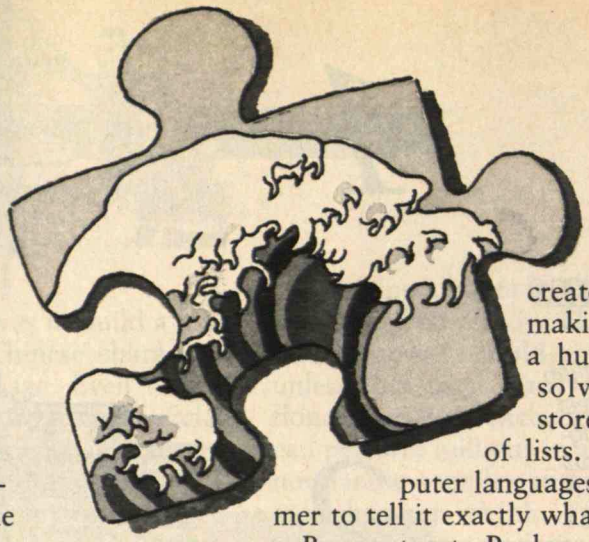


ILLUSTRATION: LONNIE KNABEL



of many leading Japanese scientists. Researchers rotate in and out of ICoT, typically spending stints of three years or so, after which they return to their original organizations. In addition to the ICoT work, some investigations are carried out in the labs of participating organizations and some are contracted to outsiders. Thus dozens of different laboratories share ICoT's vision and benefit from its work.

ICoT's managers established a three-phase timetable for the project. From April 1982 to March 1985, they concentrated on building a processor and creating a language for performing logical rather than arithmetic operations. During the second phase, which lasts until March 1989, researchers will construct a 64-processor machine as well as a parallel-processing language and an information storage and retrieval system. In the final three years of the project, scheduled to conclude in March 1992, these innovations will be incorporated into a complete prototype of a parallel-processing computer.

Proceeding with Caution

Following Japan's traditionally cautious approach to technological development, ICoT's managers have sought to make technical decisions that ensure both stability and flexibility. They must assure researchers tackling separate parts of the problem that a sudden change of direction will not make their efforts obsolete. At the same time, the directors have to choose an approach that is flexible enough to incorporate dramatic new developments in hardware or software. Fuchi notes that if devices developed outside ICoT prove superior, the final prototype of the Fifth Generation computer system will be flexible enough to accommodate them.

One initial decision ICoT researchers made was to create software based on the relatively new knowledge-processing language Prolog. Both the machine language of ICoT's hardware—the simple commands in which the computer's central processors are programmed—and the higher-level languages that users employ are based on Prolog rather than the more-established LISP.

First developed in the late 1950s, LISP (from "list processing") remains the dominant AI language. Its creators felt that the problem of making a computer behave like a human mind could best be solved if information were stored and processed in a series of lists. Like all traditional computer languages, LISP requires a programmer to tell it exactly what to do, step by step.

By contrast, Prolog (from "programming in logic")—a language developed in the 1970s—treats all statements as logical propositions, and automatically creates a database of these propositions. Without further programming, a computer running Prolog can answer questions based on the statements in its database.

For example, under LISP, writing a program to determine the color of animals would require setting up an appropriate group of lists and specifying how they should be searched for the information that determines color. Someone running Prolog, in contrast, could enter statements equivalent to "Dumbo is an elephant" and "Elephants are gray." If asked "What color is Dumbo?" the computer would simply prove an appropriate theorem and answer that Dumbo is gray.

In addition to its ability to solve many AI problems with far less programming, Prolog is well suited for parallel processing. Many processors can work together when searching a database to determine whether certain conditions are met. However, many Western experts argue that Prolog has severe disadvantages. Computers running Prolog often solve large problems more slowly than they could through a well-crafted LISP program. And when a computer running Prolog performs sluggishly, it is often difficult to figure out how to improve its speed.

ICoT's creators felt that a powerful AI machine for the 1990s would require the automatic logic capability that Prolog provides. They also felt their machine would need many of the capabilities of LISP and other AI-oriented languages. So ICoT scientists have created new Prolog-based languages that include many capabilities from LISP and related programming methods.

Risks and Returns

It is too early to predict how successful the Fifth Generation project will be. "You can't really judge the project on the basis of the first three or four years

A good technology strategy must recognize that the vision it is promoting may be wrong.

except to say that they have their heads on straight," says George Lindamood, a former Tokyo-based official of the U.S. Office of Naval Research.

No doubt the Fifth Generation project will fail to achieve at least some of its goals. The media—both Japanese and American—are likely to carry more articles describing the program as a failure. Such reports have appeared regarding most Japanese government-industry research programs. "The PIPS project was said to be a failure all throughout, until the end. Then it was said to be a success," says ICoT head Fuchi. "I think this project is the same."

But even if the Fifth Generation project's approach to parallel processing is fundamentally flawed—if the structure of the Prolog-based languages turns out to be less useful than the structure of LISP, for example—the project is likely to contribute significantly to Japan's economy. Because large Japanese corporations experience so little turnover, virtually all the researchers working on the Fifth Generation project today will still be employed by the same companies a decade or so hence. Their work on key hardware and software problems is likely to prove extremely useful regardless of the ultimate architecture of 1990s parallel-processing machines.

If the Fifth Generation project even comes close to achieving its goals, the economic benefits will be vast. If the hardware and software produced at ICoT perform better than Western products and Japanese companies are positioned to put them to use quickly, Japanese parallel-processing computers could become standard equipment, much as with other pieces of electronics apparatus such as video cameras and computer printers.

U.S. scientists have begun to address the Fifth Generation project's challenge in parallel processing. But government officials and business managers have hardly considered the larger issue of devising a strategic approach to developing business technology. The United States has failed to analyze carefully what technologies its major industries will need a decade or so in the future, let alone develop programs to assure that the industries will have them. Long-term U.S. strategy in key fields outside electronics such as machine tools, ceramic materials, and power generation is especially poor. Because of this, U.S. efforts to respond to Japan's technological challenge are unlikely to produce comparable successes.

Some steps have been taken in the right direction. For example, in response to Japanese competition, 21 leading U.S. electronics corporations have sponsored the Microelectronics and Computer Technology Corp. (MCC), based in Austin, Tex. Like Japanese technology projects, MCC brings researchers from many companies together with outside specialists to work on advanced problems.

But unlike the most important Japanese projects, MCC—and other U.S. efforts to meet the Japanese challenge—appear to have no strategy for assuring that businesses can readily commercialize the technologies they are exploring. One of the major problems is MCC's commitment to keeping its work largely secret. Such secrecy makes it impossible for the corporation to propagate its technological visions the way that Japan's technology projects do. There is little chance that the tens of thousands of business managers and engineers who must put the new technology to use will completely understand it. MCC founder Bobby Ray Inman refused to hire many of the people his sponsoring organizations sent him—and then expressed surprise that the companies seemed uncertain how they would adopt MCC technology.

Compared with a U.S. agency such as NASA, which will spend perhaps $10 billion this year, the entire collection of Japanese programs for promoting technology is modest. In Japan, government spending on industrial research is measured in the tens and hundreds of millions of dollars—not in billions.

In fact, the Japanese experience suggests that a research program that is too large tends to generate products that are too complex to be commercially successful. Moreover, if too much is spent on narrowly focused efforts, officials may be tempted to put roadblocks in the way of entrepreneurs who want to experiment in contrary directions. A good technology strategy must recognize that the vision it is promoting may be wrong. And if it is impossible to agree on a single vision that deserves promotion, there is no reason two or three competing visions cannot be funded.

The experience of the Fourth Generation project, the PIPS program, and other Japanese successes over the past two decades shows that a strategic approach to technological development can provide substantial benefits at relatively little cost and risk. Merely by focusing some of the right people on some of the right questions, similar long-term U.S. projects could make a major contribution by putting technology to work effectively. □

Slashing the Nuclear Arsenal, Chinese Technology, and R&D Scuffles

Reining in the Nuclear Arsenal

Nuclear Fallacy
By Morton H. Halperin
Ballinger, $19.95

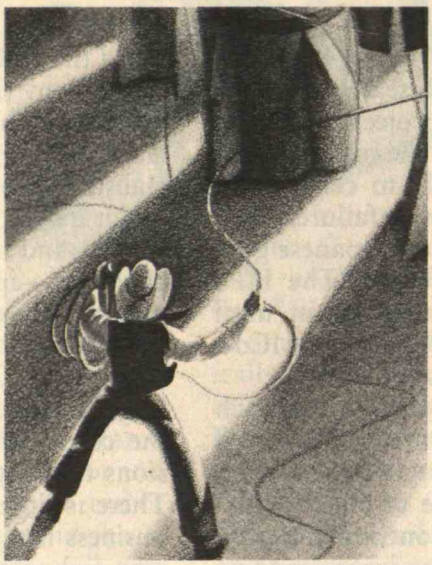
Reviewed by Thomas Powers

Among the many tough questions posed by the existence of nuclear weapons, one of the very toughest is whether nukes deserve all, some, or even any of the credit for the absence of world wars since 1945. Military professionals generally claim all, peace activists concede none, and I don't know.

A few years ago, when I thought I did know, the argument that nuclear weapons kept the peace struck me as insidious. It was true we'd had 40 years of peace between the superpowers, and it was true nukes had been ostentatiously flaunted like Teddy Roosevelt's big stick. But wasn't it also true that people had been praying for peace throughout the world? How could you prove it was the nukes and not the prayers that had done the job? I also felt then (and still feel now) that as dangerous as nukes are, we'll never get rid of them as long as people feel—especially people like presidents, secretaries of defense, and their chief advisors—that fear of nuclear war is the principal barrier to a showdown between the superpowers.

Are nuclear weapons the principal barrier to a big war of the sort that wrecked Europe twice in the first half of this century? It seems obvious that anything as frightening as nuclear weapons must have played *some* sort of inhibitory role, but the truth is that I can't think of a way to determine how much.

Morton Halperin, a former staff member of the National Security Council, has been thinking about these questions since the late 1950s, as his new book *Nuclear Fallacy* makes clear. At that time he had faith in classical deterrence—he was convinced that the superpowers could safely threaten to use nuclear weapons to prevent the onset or escalation of war. Even then his approach was very different from that of Curtis LeMay, World War II bomber general and later head of the Strategic Air Command, who fully intended to fight World War III with nuclear weapons from day one. But not until much later did Halperin take the next step and conclude that



it was thinking of nuclear weapons *as weapons* that gave us thousands, which in turn threaten global catastrophe. He believes that the only way to escape the current dilemma is to quit preparing to fight a war with them. In *Nuclear Fallacy,* he argues that a nuclear force genuinely designed for deterrence could be limited to a few score of "explosive devices."

Convincing Congress

Someone once defined the "novel" as a longish prose work that has something wrong with it. The same might be said of books on strategic policy. I very much admire Halperin's book because it is original, lucid, based on deep knowledge, practical, serious, and short. Above all, Halperin has refrained from writing down every smart thing he could think of to say about nuclear weapons. The result is a forceful argument that ordinary citizens, including presidential candidates, might remember longer than a week. More important still, the world would be a better and safer place if the next president were to adopt Halperin's position. But like all novels, *Nuclear Fallacy* has something wrong with it. In fact, it has two things wrong with it.

The first has to do with scale. It's easy to say we should stop thinking of nukes as weapons, and stop preparing to fight the next war with them, but in fact these are tall orders—a bit like saying we should quit depending on the private car for transportation. There's a lot to be said for making do with fewer cars, and many people would support the change, but as a practical matter it's far too big a thing to attempt simply because it seems like a good idea. It would be another matter if we *had* to. If the oil ran out, or if exhaust fumes began to kill the grass on the nation's putting greens, then change would occur willy nilly, however painful and difficult it might be.

Never having seen nuclear weapons, the average citizen finds it hard to realize just how common they have become in Soviet and American military preparations. Every war plan has got nukes in it, just as every military wrist wears a digital watch. The Soviet Union, in fact, would probably find it easier to abandon the private car—a relatively recent arival on Soviet streets. These weapons not only cost zillions to build; revamping military forces as if nukes had never been invented would also cost zillions. This effort would be much more expensive than, say, quintupling the endowments of all private colleges—another excellent idea. Halperin is absolutely right when he says money should be no object when it comes to remedying a dangerous situation, but such an expensive plan is bound to run into congressional opposition.

In fact, Halperin's argument failed to carry the day back when President Eisenhower first concluded that nuclear defense meant cheap defense. Now thousands of nukes are seeded thoughout the armed forces as mines and artillery shells, depth charges and backpack demolitions, bombs and missile warheads. If they ever begin to go off we shall be deeply sorry. But how to persuade the country to spend a huge share of the national budget on rejiggering defense to get less bang for the buck, in the hope that the world might be a little safer? Can we convince Congress simply by saying that Morton Halperin thinks it's a good idea, that this reviewer agrees, and that McGeorge Bundy, George Rathjens, Paul C. Warnke, Graham Allison, and Robert Jervis think so as well?

Going It Alone

The second problem with Halperin's book involves strategic theory. Halperin argues that the United States should start to reduce its arsenal unilaterally—without waiting to work out a treaty with the Russians—since a residual force of even a few hundred weapons would deter an attacker. Arms-control agreements are dif-

ILLUSTRATIONS: SALLY WERN COMPORT

ficult to negotiate. The last major one was signed and ratified 15 years ago. An agreement banning intermediate-range missiles in Europe will be nice to have, but it will leave us in danger. Another 15 years might be longer than we can afford to wait.

Yet I very much doubt that a few nukes can deter the whole range of bad things thousands are expected to prevent now. Here we enter the land of nuclear make-believe, where strategists try to guess what "nations"—i.e., small groups of terrified government officials—would do in the event whole cities began to disappear around them. How would the United States respond if the Soviet Union attacked a dozen major NATO airfields in Europe with nuclear weapons? Halperin says the Soviets wouldn't, but what *if* . . .?

The melancholy truth is that a United States armed with only a few hundred nukes would never dare to use them against a Soviet Union armed with thousands. Our shrunken inventory would soon be drained by a tit-for-tat exchange, and an attack on Soviet cities would bring a devastating response. Nuclear threats are governed by a law of proportion: either side can deter only those things it can actually do itself. A threat to use a single nuke cannot deter an attack with scores any more than a threat to use scores can deter an attack with one. The first is too paltry, the second too dangerous.

Halperin does not address this point, so I'm not sure how he would respond. I suspect he'd say, so what? So maybe there would be risks in cutting back American reliance on nuclear weapons unilaterally. All the more reason to recognize the danger, to start thinking differently, and to negotiate joint reductions. These are sensible arguments. In making them clearly, Halperin's fine book does everything a book can do, which is to guide and persuade. My guess is that it will sell a few thousand copies, some of which will be read. The burden will then fall on readers to turn history around, to convince thousands of defense professionals that deterrence is broke and needs fixing, and to uproot 40 years of bedrock faith that nukes make war impossible.

But why hurry? Deterrence has worked since 1945, hasn't it?

THOMAS POWERS is a contributing editor of the Atlantic *and author of* Total War: What It Is, How It Got That Way *(Morrow, 1988).*

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China's technological achievements would shock those who saw it as the "land of eternal stagnation."

The Wonders of Chinese Technology

The Genius of China
By Robert Temple
Simon and Schuster, $19.95

Reviewed by Peter C. Perdue

Many readers will be aware of the work of Joseph Needham, the world's leading historian of Chinese science. His multivolume work *Science and Civilization in China* surveys Chinese discoveries and inventions in all major fields of science and technology. Although Needham's volumes are chock-full of fascinating details and written in an engaging and elegant style, their sheer bulk and expense will put off many people. Thus, Robert Temple's *The Genius of China* provides a convenient introduction to Needham's opus for anyone with even the most casual interest in the history of science and technology.

Temple organizes his book around 100 major inventions in which the Chinese anticipated the Western world. A chart on the inside cover shows the astonishingly long time lag between many discoveries made in China and their adoption in Europe: 1,200 years for the umbrella, 1,700 years for the stirrup, 1,400 years for natural gas. Even those familiar with Needham's work will find insights here, for Temple draws on unpublished material on topics such as biological pest control, porcelain, and "strong beer." Color pictures and sketches of hang gliders, water clocks, iron plows, and suspension bridges make this book visually delightful as well.

One comes away with a single dominant impression: that classical Chinese civilization abounded with tinkerers, investigators, and officials devoted to extending their knowledge of the world and improving their people's standard of living. Such a conclusion would shock nineteenth-century Europeans who saw China as the "land of eternal stagnation." Both Temple's and Needham's works demonstrate the utter falsity of smug notions about the inferiority of the non-Western world. For Needham, science is a "universal river" drawing upon the contributions of many nations.

Both historians also show that the ancient Chinese had to deal with the same troubling doubts about the benefits of technological advance that we face today.



The saga of the discovery of gunpowder provides an example. Around 850 A.D., an unfortunate Taoist alchemist searching for elixirs of immortality burned down his house while discovering the explosive properties of a mixture of saltpeter, potassium nitrate, and carbon. The Chinese soon learned to exploit the destructive force of the new mixture, using it first in smoke bombs and then in flame throwers, grenades, mortars, and poison gas. It also served as a propellant for other lethal missiles. All these weapons were used in battle before Europeans caught on to the idea in the thirteenth century.

Thus the Chinese can claim dubious credit for developing the world's most terrible destructive force until nuclear weaponry. Yet they also exploited the beneficial uses of gunpowder—blasting out mines, for example. Today's achievements in space travel also have their roots in eleventh-century Chinese discoveries of jet propulsion and rocketry that followed from their use of gunpowder. Like us, the Chinese have long known technology's tragic combination of destructive power and great benefits.

Imitation or Invention?

Although Temple's book is an enjoyable way to sample Needham's work, his approach has its costs. Singling out great inventions in which China was far in advance of the West tempts us to view history as a horse race, with all civilizations rushing along a single time line. Temple simply inverts classic unilinear Western theories of development when he puts the Chinese in front. He tries hard to show that travelers transmitted nearly every important invention to Europe. Yet the question of whether Westerners developed such inventions independently or simply imitated the Chinese is difficult to answer. Many historians are not convinced that Europe directly adopted the theory of equal temperament outlined by Chu Tsai-yu in 1584, for example, or that there is any connection between the Chinese perfection of water clocks and the European invention of mechanical escapement.

Temple's approach also obscures the fascinating insights to be gained from comparing the way two cultures approach the same problem. For example, the Chinese, unlike the Greeks, stressed algebra far more than geometry, developing solutions to higher-order equations and even the rudiments of matrix algebra. They, too, proved the Pythagorean theorem, but did so using an algebraic proof completely different from Euclid's method.

Temple, moreover, sheds no light on the great mystery that has preoccupied the Chinese: why did modern science—the "experimental philosophy" of Galileo's time—arise only in Europe? Many historians blame this phenomenon and China's resulting economic backwardness on its "feudal legacy." The fullest statement of this view in English comes from Qian Wenyuan, a theoretical physicist now living in the United States who passionately attacks Needham's claims for China's scientific achievements. In *The Great Inertia: Scientific Stagnation in Traditional China,* he finds the secret of Western superiority in its Greek and Christian tradition of individualism. For him, the dead hand of the Chinese bureaucratic state has long stifled the creativity essential to scientific innovation, imposing a totalitarian ideology of Confucian deference and discouraging the independent investigation of nature.

Like his scientific colleagues who remained in China, Qian suffered terribly during the Cultural Revolution. And like Fang Lizhi, another physicist recently purged from the Communist Party for his blunt critique of bureaucratic privilege and dogmatic intolerance, Qian believes that modern scientific development will never be possible in China until the party machine permits true freedom of thought.

However, his argument is uncomforta-

The close relationship between an exceptionally powerful CEO and company scientists proved RCA's undoing.

bly oversimplified. Seventeenth-century Europe, the home of witchburning and the Inquisition, hardly seems to have been less intolerant than the imperial regimes of China. One could easily argue that it was not freedom but the pursuit of dominance through warfare, first in Europe and later around the globe, that provided the greatest stimulus to Western technological advance. Meanwhile the Manchu regime, having established *pax sinica* by the mid-seventeenth century, chose to devote its resources to sustaining its people rather than devastating other populations.

The most critical element in scientific progress seems to be the formation of communities of professional researchers who promote learning through rigorous criticism and peer review. Many Chinese discoveries, such as the seismograph, turned out to be isolated achievements forgotten in later centuries because they were not refined by others.

Simple dichotomies between repressive East and free West fall apart in the face of the complexity of interaction between rulers and intellectuals in both cultures. Temple's and Needham's books supply rich material for examining the varieties of scientific investigation in one of the world's great civilizations.

PETER C. PERDUE is associate professor of history at M.I.T.

When R&D Gets Out of Hand

RCA and the VideoDisc
By Margaret B.W. Graham
Cambridge University Press, $19.95

Reviewed by A. George Schillinger

In 1984 RCA, one of the leading U.S. producers of technology-intensive products, withdrew its VideoDisc from the market, thus abandoning a 15-year effort to develop a low-cost video player. The fiasco was RCA's second in a decade, following on the heels of its withdrawal from the computer business in 1975. These failures were symptomatic of the weaknesses in strategy that contributed directly to RCA's demise as an independent entity: GE acquired the firm in 1986.

In *RCA and the VideoDisc,* Margaret B.W. Graham provides an incisive and well-documented account of what went

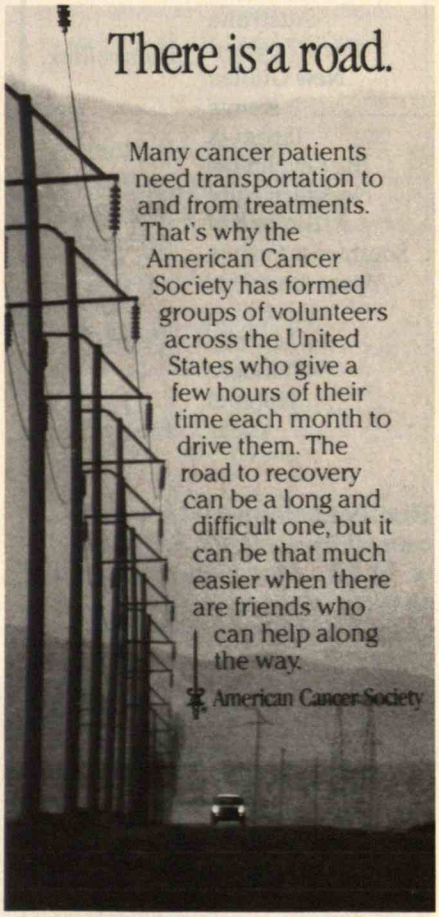


wrong. As a historian and expert in business administration, she had access to RCA documents and interviewed employees over a period of years. Her inquiry centers on the role of the company's R&D in producing a new technology crucial to its success. For it was management's failure to adjudicate tensions between researchers and those responsible for producing and marketing the new technology that led to the VideoDisc disaster.

The corporate history of RCA—and that of its forerunner, American Marconi—provides essential background to the VideoDisc story. The vision and forceful leadership of RCA chief executive David Sarnoff, whose tenure with the company spanned more than half a century, loom large in this account. For although he had no technical training, Sarnoff is among the first business leaders to understand that technological innovation is essential to a firm's survival and growth. To maintain RCA's leadership through successive generations of electronic technologies, he created and nurtured RCA Laboratories (later known as the David Sarnoff Research Center), one of the outstanding industrial research divisions of all time.

Yet this close and special relationship between an exceptionally powerful CEO and the company's scientists and engineers was a key factor in RCA's undoing. The central research unit exerted undue influence on the firm's overall strategy, making decisions commonly the purview of operating divisions more knowlegeable about consumer preferences. Instead of concentrating on basic research and creating products according to the company's goals, the labs acted as corporate entrepreneur, inducing RCA to develop a video player of dubious commercial appeal.

RCA scientists and engineers based their development efforts on two erroneous assumptions. They thought consumers wanted a video player that functioned as a kind of visual phonograph, producing both pictures and high-quality sound. They also decided that magnetic tape—the key to the now-ubiquitous Japanese VCR—was too expensive to be used in a mass-market consumer item. These assumptions led them to choose the wrong basic technology: they elected to create a closed disk that could not be used to record off the air. In their singleminded quest to create the most cost-effective mass-market product, RCA engineers did not anticipate that both the widespread



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CONTINUED FROM PAGE 77

popularity of video players and the dramatic Japanese success in reducing manufacturing costs would bring down the price of machine and tape. The Consumer Electronics Division alone championed magnetic tape as the right medium for the VideoDisc.

VideoDisc advocates at all levels of the corporation were also lured by the "razor-blade" concept: the idea that consumers who bought VideoDiscs would buy RCA-made copies of operas, movie classics, and popular sporting events to play on their machines. These advocates greatly underestimated both the time required to create a comprehensive set of such programs and the difficulty of capturing a market with two mutually dependent products.

The company's flawed strategy led to a precious loss of time in the race with Japanese manufacturers. The latter realized that the public would pay extra for video players with more features, and Japanese producers soon claimed most of the market. Ironically, in 1977 RCA decided to buy VCRs from Matshushita and sell them under the RCA label.

Rivalry between R&D and operating divisions is typical of technology-based businesses, but the dominance of the labs in this case was unusual. David Sarnoff was no longer at the helm of RCA during most of the VideoDisc project, and the corporate culture he bequeathed was unable to emerge as an industry leader as it had repeatedly done in the past. Sarnoff's successors never came to grips with the problem of clearly delineating the labs' role in corporate decision making.

Graham concludes her account with a refreshingly jargon-free analysis of the complex character of R&D as a corporate institution. As she makes clear, decades after its acceptance as an essential corporate function, R&D all too often remains an enigma to managers under pressure to produce short-term results. Executives frequently do not take the time to understand what their scientists and engineers are saying and doing. Managers also seem to find it difficult to learn from the mistakes of their peers. The result is that U.S. businesses do not make the best use of their technological knowhow, to the detriment of the health of U.S. industry.

A. GEORGE SCHILLINGER is professor of management at Polytechnic University in New York and editor of Technology In Society.

CONTINUED FROM PAGE 20

understand, so their creators are not likely to capture the public imagination.

I lean toward another explanation: perhaps we are simply jaded. After hundreds of years of technological advances, with discoveries now accelerating exponentially, we are no longer thrilled by a new breakthrough, no longer inspired by an inventor, however brilliant.

Not that we have lost our capacity for wonder—every sunrise or newborn child shows us this is not so. Rather, we no longer associate technology with salvation. For millenia human societies lived in dread of famine and plague, and to the extent that technology promised relief, it evoked wonder and delight. The Industrial Revolution brought miraculous new freedoms and sensory experiences—travel, communication, a cornucopia of consumer goods. To a technologically naive and newly liberated populace there was every reason to view inventors as heroes. But now that so many of us can take shelter and food for granted, and have a surfeit of TVs, CDs, and PCs, technologists have lost their messianic appeal.

Not that we have achieved a state of utopian contentment. We still have many vital concerns, some of which are reflected in the renown of individuals, including a few scientists and engineers. For example, the celebrity status of Lee Iacocca—engineer-manufacturer-salesman—speaks to our anxiety about maintaining our position as an industrial power. The continuing fame of Jonas Salk indicates how anxious we are to be free of disease.

Probably our greatest obsession is nuclear war; witness the continuing renown of Robert Oppenheimer and Edward Teller, "Father of the H-Bomb." Architects of peace, should any arise in the science-technology community, might conceivably become the ultimate heroes of our time. Is it a fantasy to think that computers, satellites, lasers, and the like—the components of what we today call Star Wars—might eventually be used to create a multinational system of mutual security, an antidote to war? If that were to happen, its creators might yet become the stuff of legend.

In the meantime, the lack of renown for technologists like Kilby and Noyce attests to our mixed feelings about the uses of technology. Happily, fame is not the only measure of genius, and their deeds burn brightly in the firmament of human achievement. □

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Hard Times Ahead for Labor and Housing

Why Unions Have Failed

Two major causes of a "precipitous decline in the extent of unionization in the United States" in the 1970s and 1980s, says Henry S. Farber, professor of economics:

☐ The increasing job satisfaction of non-union workers.

☐ The decreasing confidence among non-union workers in unions' ability to improve wages and working conditions.

Farber calls the unions' experience "a virtual rout": by 1985 less than 15 percent of non-agricultural workers in the United States were unionized, down from more than 25 percent in 1973.

Throughout that period, notes Farber, U.S. industries have been locked in intense foreign competition. In this environment, overt anti-union behavior has been acceptable, and companies have felt stronger incentives to resist the rising cost of unionization.

But anti-union sentiment among non-unionized workers, not company opposition, has been the unions' most important problem, says Farber. The dramatic rise in non-union workers' satisfaction with their pay and job security that occurred between 1977 and 1984 may make it "nearly impossible" for unions to recoup their losses, he believes.

High Risks for Low-Income Tenants

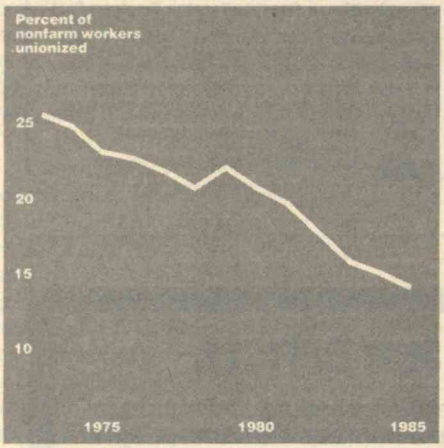
Four forces are converging to create a serious shortage of low-cost rental housing in the United States by the last years of this century, says Phillip L. Clay of M.I.T.'s Department of Urban Studies and Planning:

☐ The percentage of the population that is poor, as defined by the Census Bureau, is rising.

☐ The number of low-rent units is falling because of high housing demand.

☐ Expiring federal contracts and restrictions put many of today's 1.9 million federally assisted low-income rental units at risk.

☐ By ending tax shelters, federal tax reform is pressuring real estate investors to increase rents and decrease investments in low- and moderate-priced housing.



Unionization among non-agricultural workers has dropped precipitously in the United States since the early 1970s—"a virtual rout," says Henry S. Farber, professor of economics.

In a report for the Neighborhood Reinvestment Corp., Clay estimates a decrease of 27 percent (from 12.9 million) in low-rent units in the United States by 2003. And in the same period, he says, the number of households needing low-rent accommodations will rise from 11.9 million to 17.2 million, up 44 percent.

Clay's recommendations: government incentives to discourage private owners from converting subsidized housing; new or renewed federal programs; emphasis by state and local governments on acquiring housing suitable for low-income people; government action to keep housing affordable; and more effort by community groups to create and preserve low-rent housing. "While local organizations have untapped potential for an expanded role," writes Clay, "the task of being steward of the nation's housing resources is devolving onto them faster than their capacity grows."

Pathways of Music for the Blind

A new system using audible clues to help sight-impaired people find their way through rooms and corridors has come from the Eric P. and Evelyn E. Newman Laboratory for Biomechanics and Human Rehabilitation at M.I.T.

Sight-impaired users wear special reflective tape on their clothing. As they pass down a corridor, ceiling-mounted infrared sensors detect the tape and activate tiny radio transmitters that broadcast distinctive music—a different tune for each location—to the users' earphones.

This "musical pathway" is the concept of Mark Uslan, consultant on orientation and mobility for the American Federation for the Blind, which has sponsored the work at M.I.T.

How Vision Grows

Between the third and seventh months of life, infant boys lag behind infant girls in one key area of vision development—vernier acuity, the application of brain function to the processing of visual images. Before and after this period, the males do not suffer from the disadvantage, and male and female vision develops in essentially the same way.

Professor Richard M. Held guesses that elevated testosterone levels in male babies are responsible for the slower pace of vision development. But research continues; the discovery, he says, raises important questions about different paths of brain development in males and females, and about the role of hormones such as testosterone in brain and nervous-system development.

Collision Avoidance

Five engineers at M.I.T.'s Lincoln Laboratory have been cited by the Federal Aviation Administration (FAA) for their role in developing a new collision-avoidance system that the agency may require on all jetliners by as early as 1992.

The Lincoln air-to-air surveillance system is based on detection of signals from air-traffic-control transponders, which are designed to enhance aircraft images on controller screens. The achievement, says FAA in its citation, "points the way to . . . a new era in air safety."

Lincoln Laboratory, operated by M.I.T. for the U.S. Air Force, is conducting more than $400 million of research for the Department of Defense and other federal agencies in the fiscal year that ends next September 30.



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